10 CHAPTERS

PRIORITY A

5 years of PYQs
JEE MAIN 2020 – JEE MAIN 2024

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INTRODUCTION

This contains **JEE Main 2020 to JEE Main 2024 PYQs** of **10 Must do Chapters** from Physics which contributes to +60 Marks atleast.

The best part is that every questions explanation video is also there which will clear all possible doubts of JEE Main Aspirants and will improve their concept application.

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Make sure to Solve in ***Time Bound Manner*** *(For example 1 Hr for 25 Questions)*

LIST OF QUESTIONS BASED ON REMOVED TOPICS FROM JEE MAIN				
	2020	2021	2022	2023
KTG & Thermodynamics *(Carnot Engine & questions based on it)*	22, 23, 24, 30, 32	Feb - 8 Mar - 4, 6 July - 10, 15 Aug - 3, 7, 8	June - 1, 3, 6, 9, 12, 14, 23 July - 3, 8, 10	Jan - 3, 9, 19 Apr - 6, 16
	2020	2021	2022	2023
Current Electricity *(Colour Code, Potentiometer)*	14, 15, 19	Feb - 6 Mar - July - 6, 8, 9 Aug - 7	June - 2, 4, 14 July - 4, 8, 16	Jan - 2, 16, 19 Apr -
	2020	2021	2022	2023
Moving Charges & Magnetism *(Earth Magnetism, Hysteresis, Cyclotron)*	25, 26	Feb - Mar - 1 July - 1, 4 Aug -	June - 3, 19 July - 10, 12, 13, 20	Jan - Apr - 7, 17
	2020	2021	2022	2023
Modern Physics *(Radioactivity Decay Law, α-β-γ Decay, Davisson Germer Experiment)*	8, 9, 10, 11	Feb - 11, 13 Mar - 4, 5, 13, 15 July - 1, 2, 5, 7, 8, 12, 13, 18, 19, 21 Aug - 4, 5, 9, 14	June - 6, 7, 10, 12, 14, 23, 24, 27, 29 July - 6, 13, 15, 17, 18, 21, 25	Jan - 8, 20, 21, 22, 29, 30, 31 Apr - 10, 15, 16, 20, 34

**For remaining 6 chapters all questions are a part of syllabus*

1. The dimension of $B^2/2\mu_0$, where B is magnetic field and μ_0 is the magnetic permeability of vacuum, is
(a) ML^2T^{-2} (b) $ML^{-1}T^{-2}$
(c) MLT^{-2} (d) ML^2T^{-1}

2. A quantity f is given by $f=\sqrt{hc^5/G}$ where c is speed of light, G universal gravitational constant and h is the Plank's constant. Dimension of f is that of
(a) area (b) volume
(c) momentum (d) energy

3. The dimension of stopping potential V_0 in photoelectric effect in units of Planck's constant 'h', speed of light 'c', Gravitational constant 'G' and ampere A is
(a) $h^{-2/3}c^{-1/3}G^{4/3}A^{-1}$ (b) $h^0c^5G^{-1}A^{-1}$
(c) $h^2G^{3/2}c^{1/3}A^{-1}$ (d) $h^{1/3}G^{2/3}c^{1/3}A^{-1}$

4. If speed V, area A and force F are chosen as fundamental units, then the dimension of Young's modulus will be
(a) $FA^{-1}V^0$ (b) FA^2V^{-1}
(c) FA^2V^{-2} (d) FA^2V^{-3}

5. If momentum (P), area (A) and time (T) are taken to be the fundamental quantities then the dimensional formula for energy is
(a) $[PA^{-1}T^{-2}]$ (b) $[PA^{1/2}T^{-1}]$
(c) $[P^2AT^{-2}]$ (d) $[P^{1/2}AT^{-1}]$

6. Amount of solar energy received on the earth's surface per unit area per unit time is defined a solar constant. Dimension of solar constant is
(a) ML^2T^{-2} (b) MLT^{-2}
(c) $M^2L^0T^{-1}$ (d) ML^0T^{-3}

7. Dimensional formula for thermal conductivity is (here K denotes the temperature)
(a) $MLT^{-3}K$ (b) $MLT^{-2}K$
(c) $MLT^{-2}K^{-2}$ (d) $MLT^{-3}K^{-1}$

8. A quantity x is given by (IFv^2/WL^4) in terms of moment of inertia I, force F, velocity v, work W and Length L. The dimensional formula for x is same as that of
(a) Planck's constant (b) Force constant
(c) Energy density (d) Coefficient of viscosity

9. The quantities $x=\frac{1}{\sqrt{\mu_0\varepsilon_0}}$, $y=\frac{E}{B}$ and $z=\frac{l}{CR}$ are defined where C-capacitance, R-resistance, l-length, E-Electric field. B-magnetic field and ε_0, μ_0 -free space permittivity and permeability respectively. Then
(a) Only x and y have the same dimension
(b) x, y and z have the same dimension
(c) Only x and z have the same dimension
(d) Only y and z have the same dimension

10. A simple pendulum is being used to determine the value of gravitional acceleration g at a certain place. The length of the pendulum is 25.0 cm and a stop watch with 1 s resolution measures the time taken for 40 oscillations to be 50 s. The accuracy in g is
(a) 2.40% (b) 5.40%
(c) 4.40% (d) 3.40%

11. A physical quantity z depends on four observables a, b, c and d, as $z=\frac{a^2b^{2/3}}{\sqrt{c}d^3}$. The percentage of error in the measurement of a, b, c and d are 2%, 1.5%, 4% and 2.5% respectively. The percentage of error in z is
(a) 12.25 % (b) 14.5 %
(c) 16.5 % (d) 13.5 %

12. For the four sets of three measured physical quantities as given below, which of the following options is correct?
(i) $A_1=24.36,\ B_1=0.0724,\ C_1=256.2$
(ii) $A_2=24.44,\ B_2=16.082,\ C_2=240.2$
(iii) $A_3=25.2,\ B_3=19.2812,\ C_3=236.183$
(iv) $A_4=25,\ B_4=236.191,\ C_4=19.5$
(a) $A_1+B_1+C_1<A_2+B_2+C_2=A_3+B_3+C_3<A_4+B_4+C_4$
(b) $A_1+B_1+C_1=A_2+B_2+C_2=A_3+B_3+C_3=A_4+B_4+C_4$
(c) $A_1+B_1+C_1<A_3+B_3+C_3<A_2+B_2+C_2<A_4+B_4+C_4$
(d) $A_4+B_4+C_4<A_1+B_1+C_1<A_3+B_3+C_3<A_2+B_2+C_2$

13. If the screw on a screw-gauge is given six rotations, it moves by 3 mm on the main scale. If there are 50 divisions on the circular scale the least count of the screw gauge is
(a) 0.001 cm (b) 0.01 cm
(c) 0.02 mm (d) 0.001 mm

14. Using screw gauge of pitch 0.1 cm and 50 divisions on its circular scale, the thickness of an object is measured. It should correctly be recorded as
(a) 2.123 cm (b) 2.125 cm
(c) 2.121 cm (d) 2.124 cm

15. A screw gauge has 50 divisions on its circular scale. The circular scale is 4 units ahead of the pitch scale marking, prior to use. Upon one complete rotation of the circular scale, a displacement of 0.5 mm is noticed on the pitch scale. The nature of zero error involved, and the least count of the screw gauge, are respectively
(a) Negative, $2\mu m$ (b) Positive, $10\mu m$
(c) Positive, $0.1\mu m$ (d) Positive, 0.1 mm

16. A student measuring the diameter of a pencil of circular cross-section with the help of a vernier scale records the following four readings 5.50 mm, 5.55 mm, 5.45 mm, 5.65 mm. The average of these four readings is 5.5375 mm and the standard deviation of the data is 0.07395 mm. The average diameter of the pencil should therefore be recorded as
(a) (5.5375 ± 0.0739) mm (b) (5.538 ± 0.074) mm
(c) (5.54 ± 0.07) mm (d) (5.5375 ± 0.0740) mm

SOLUTION

17. The least count of the main scale of a vernier callipers is 1 mm. Its vernier scale is divided into 10 divisions and coincide with 9 divisions of the main scale. When jaws are touching each other, the 7th division of vernier scale coincides with a division of main scale and the zero of vernier scale is lying right side of the zero of main scale. When this vernier is used to measure length of a cylinder the zero of the vernier scale lies between 3.1 cm and 3.2 cm and 4th VSD coincides with a main scale division. The length of the cylinder is (VSD is vernier scale division)

(a) 3.21 cm (b) 2.99 cm
(c) 3.07 cm (d) 3.2 cm

18. The density of a solid metal sphere is determined by measuring its mass and its diameter. The maximum error in the density of the sphere is $(x/100)\%$. If the relative errors in measuring the mass and the diameter are 6.0% and 1.5% respectively, the value of x is

19. The sum of two forces $\vec{P}$ and $\vec{Q}$ is $\vec{R}$ such that $|\vec{R}| = |\vec{P}|$. The angle θ (in degrees) that the resultant of $2\vec{P}$ and $\vec{Q}$ will make with $\vec{Q}$ is

SOLUTION

ANSWER KEY

1. b
2. d
3. b
4. a
5. b
6. d
7. d
8. c
9. b
10. c
11. b
12. a
13. a
14. d
15. b
16. c
17. c
18. 1050
19. 90

Feb Attempt

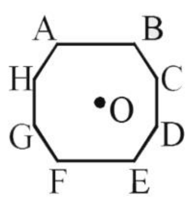
1. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Measured value of 'L' is 1.0 m from meter scale having a minimum division of 1 mm and time of one complete oscillation is 1.95 s measured from stopwatch of 0.01 s resolution. The percentage error in the determination of 'g' will be :
(1) 1.13% (2) 1.03%
(3) 1.33% (4) 1.30%

2. The workdone by a gas molecule in an isolated system is given by, $W = \alpha\beta^2 e^{-\frac{x^2}{\alpha kT}}$, where x is the displacement, k is the Boltzmann constant and T is the temperature, α and β are constants. Then the dimension of β will be :
(1) $[M\ L^2\ T^{-2}]$ (2) $[M\ L\ T^{-2}]$
(3) $[M^2\ L\ T^2]$ (4) $[M^0\ L\ T^0]$

3. If e is the electronic charge, c is the speed of light in free space and h is Planck's constant, the quantity $\frac{1}{4\pi\varepsilon_0}\frac{|e|^2}{hc}$ has dimensions of :
(1) $[M^0\ L^0\ T^0]$ (2) $[L\ C^{-1}]$
(3) $[M\ L\ T^{-1}]$ (4) $[M\ L\ T^0]$

4. If $\vec{P}\times\vec{Q} = \vec{Q}\times\vec{P}$, the angle between $\vec{P}$ and $\vec{Q}$ is θ $(0° < \theta < 360°)$. The value of 'θ' will be _________°.

5. In an octagon ABCDEFGH of equal side, what is the sum of
$\overrightarrow{AB}+\overrightarrow{AC}+\overrightarrow{AD}+\overrightarrow{AE}+\overrightarrow{AF}+\overrightarrow{AG}+\overrightarrow{AH}$'
if, $\overrightarrow{AO} = 2\hat{i}+3\hat{j}-4\hat{k}$
(1) $-16\hat{i}-24\hat{j}+32\hat{k}$ (3) $16\hat{i}+24\hat{j}+32\hat{k}$
(2) $16\hat{i}+24\hat{j}-32\hat{k}$ (4) $16\hat{i}-24\hat{j}+32\hat{k}$



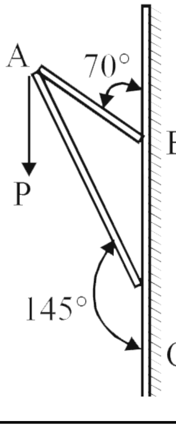
6. In a typical combustion engine the work done by a gas molecule is given $W = \alpha^2\beta e^{\frac{-\beta x^2}{kT}}$, where x is the displacement, k is the Boltzmann constant and T is the temperature. If α and β are constants, dimensions of α will be :
(1) $[MLT^{-2}]$ (3) $[M^2LT^{-2}]$
(2) $[M^0LT^0]$ (4) $[MLT^{-1}]$

March Attempt

1. One main scale division of a vernier callipers is 'a' cm and n^{th} division of the vernier scale coincide with $(n-1)^{th}$ division of the main scale. The least count of the callipers in mm is :
(1) $\frac{10\,na}{(n-1)}$ (2) $\frac{10a}{(n-1)}$
(3) $\left(\frac{n-1}{10n}\right)a$ (4) $\frac{10a}{n}$

2. The resistance $R = \frac{V}{I}$, where $V = (50 \pm 2)V$ and $I = (20 \pm 0.2)A$. The percentage error in R is 'x' %. The value of 'x' to the nearest integer is __________.

3. Consider a frame that is made up of two thin massless rods AB and AC as shown in the figure. A vertical force $\vec{P}$ of magnitude 100 N is applied at point A of the frame.
Suppose the force is $\vec{P}$ resolved parallel to the arms AB and AC of the frame. The magnitude of the resolved component along the arm AC is xN. The value of x, to the nearest integer, is
[Given : sin(35°) = 0.573, cos(35°) = 0.819
sin(110°) = 0.939, cos(110°) = –0.342]



SOLUTION

4. In order to determine the Young's Modulus of a wire of radius 0.2 cm (measured using a scale of least count = 0.001 cm) and length 1m (measured using a scale of least count = 1 mm), a weight of mass 1kg (measured using a scale of least count = 1g) was hanged to get the elongation of 0.5 cm (measured using a scale of least count 0.001 cm). What will be the fractional error in the value of Young's Modulus determined by this experiment ?

(1) 0.14% (3) 9%

(2) 0.9% (4) 1.4%

5. The vernier scale used for measurement has a positive zero error of 0.2 mm. If while taking a measurement it was noted that '0' on the vernier scale lies between 8.5 cm and 8.6 cm, vernier coincidence is 6, then the correct value of measurement is_____ cm.
(least count = 0.01 cm)

(1) 8.36 cm (2) 8.54 cm

(3) 8.58 cm (4) 8.56 cm

6. The time period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{\ell}{g}}$. The measured value of the length of pendulum is 10 cm known to a 1mm accuracy. The time for 200 oscillations of the pendulum is found to be 100 second using a clock of 1s resolution. The percentage accuracy in the determination of 'g' using this pendulum is 'x'. The value of 'x' to the nearest integer is:-

(1) 2% (2) 3%

(3) 5% (4) 4%

7. In the experiment of Ohm's law, a potential difference of 5.0 V is applied across the end of a conductor of length 10.0 cm and diameter of 5.00 mm. The measured current in the conductor is 2.00 A. The maximum permissible percentage error in the resistivity of the conductor is :-

(1) 3.9 (2) 8.4

(3) 7.5 (4) 3.0

8. The radius of a sphere is measured to be (7.50 ± 0.85) cm. Suppose the percentage error in its volume is x. The value of x, to the nearest x, is_______.

July Attempt

1. If $\vec{A}$ and $\vec{B}$ are two vectors satisfying the relation $\vec{A}\cdot\vec{B} = |\vec{A}\times\vec{B}|$. Then the value of $|\vec{A}-\vec{B}|$ will be :

(1) $\sqrt{A^2+B^2}$

(2) $\sqrt{A^2+B^2+\sqrt{2}AB}$

(3) $\sqrt{A^2+B^2+2AB}$

(4) $\sqrt{A^2+B^2-\sqrt{2}AB}$

2. The entropy of any system is given by

$$S = \alpha^2\beta\ln\left[\frac{\mu kR}{J\beta^2}+3\right]$$

where α and β are the constants. μ, J, k and R are no. of moles, mechanical equivalent of heat, Boltzmann constant and gas constant respectively.

$$\left[\text{Take } S = \frac{dQ}{T}\right]$$

Choose the incorrect option from the following :

(1) α and J have the same dimensions.

(2) S, β, k and μR have the same dimensions.

(3) S and α have different dimensions.

(4) α and k have the same dimensions.

3. If time (t), velocity (v), and angular momentum (l) are taken as the fundamental units. Then the dimension of mass (m) in terms of t, v and l is :

(1) $[t^{-1}v^{1}l^{-2}]$

(2) $[t^{1}v^{2}l^{-1}]$

(3) $[t^{-2}v^{-1}l^{1}]$

(4) $[t^{-1}v^{-2}l^{1}]$

4. Two vectors $\vec{P}$ and $\vec{Q}$ have equal magnitudes. If the magnitude of $\vec{P}+\vec{Q}$ is n times the magnitude of $\vec{P}-\vec{Q}$, then angle between $\vec{P}$ and $\vec{Q}$ is :

(1) $\sin^{-1}\left(\frac{n-1}{n+1}\right)$ (2) $\cos^{-1}\left(\frac{n-1}{n+1}\right)$

(3) $\sin^{-1}\left(\frac{n^2-1}{n^2+1}\right)$ (4) $\cos^{-1}\left(\frac{n^2-1}{n^2+1}\right)$

SOLUTION

5. What will be the projection of vector $\vec{A} = \hat{i} + \hat{j} + \hat{k}$ on vector $\vec{B} = \hat{i} + \hat{j}$?

(1) $\sqrt{2}(\hat{i} + \hat{j} + \hat{k})$ (2) $2(\hat{i} + \hat{j} + \hat{k})$

(3) $\sqrt{2}(\hat{i} + \hat{j})$ (4) $(\hat{i} + \hat{j})$

6. Three particles P, Q and R are moving along the vectors $\vec{A} = \hat{i} + \hat{j}$, $\vec{B} = \hat{j} + \hat{k}$ and $\vec{C} = -\hat{i} + \hat{j}$ respectively. They strike on a point and start to move in different directions. Now particle P is moving normal to the plane which contains vector $\vec{A}$ and $\vec{B}$. Similarly particle Q is moving normal to the plane which contains vector $\vec{A}$ and $\vec{C}$. The angle between the direction of motion of P and Q is $\cos^{-1}\left(\frac{1}{\sqrt{x}}\right)$. Then the value of x is ________.

7. Three students S_1, S_2 and S_3 perform an experiment for determining the acceleration due to gravity (g) using a simple pendulum. They use different lengths of pendulum and record time for different number of oscillations. The observations are as shown in the table.

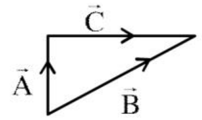
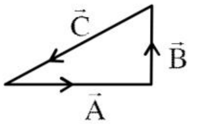
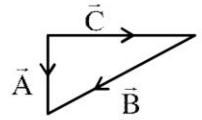
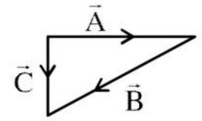
Student No.	Length of pendulum (cm)	No. of oscillations (n)	Total time for n oscillations	Time period (s)
1.	64.0	8	128.0	16.0
2.	64.0	4	64.0	16.0
3.	20.0	4	36.0	9.0

(Least count of length = 0.1 m

least count for time = 0.1 s)

If E_1, E_2 and E_3 are the percentage errors in 'g' for students 1, 2 and 3 respectively, then the minimum percentage error is obtained by student no._____.

8. Match **List I** with **List II**.

List I		List II	
(a)	$\vec{C} - \vec{A} - \vec{B} = 0$	(i)	
(b)	$\vec{A} - \vec{C} - \vec{B} = 0$	(ii)	
(c)	$\vec{B} - \vec{A} - \vec{C} = 0$	(iii)	
(d)	$\vec{A} + \vec{B} = -\vec{C}$	(iv)	

Choose the correct answer from the options given below :

(1) (a) → (iv), (b) → (i) , (c) → (iii), (d) → (ii)

(2) (a) → (iv), (b) → (iii) , (c) → (i), (d) → (ii)

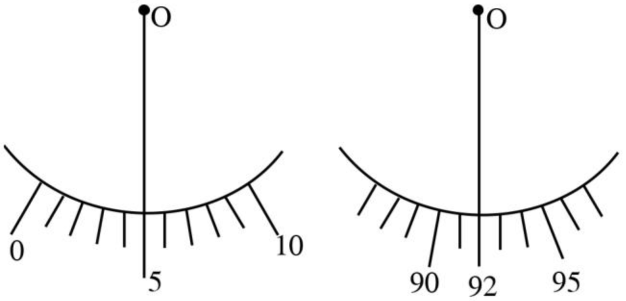
(3) (a) → (iii), (b) → (ii) , (c) → (iv), (d) → (i)

(4) (a) → (i), (b) → (iv) , (c) → (ii), (d) → (iii)

9. Student A and Student B used two screw gauges of equal pitch and 100 equal circular divisions to measure the radius of a given wire. The actual value of the radius of the wire is 0.322 cm. The absolute value of the difference between the final circular scale readings observed by the students A and B is ________.

[Figure shows position of reference 'O' when jaws of screw gauge are closed]

Given pitch = 0.1 cm.



Screw gauge (A) Screw gauge (B)

SOLUTION

10. The force is given in terms of time t and displacement x by the equation

$F = A \cos Bx + C \sin Dt$

The dimensional formula of $\frac{AD}{B}$ is :

(1) $[M^0 L T^{-1}]$ (2) $[M L^2 T^{-3}]$

(3) $[M^1 L^1 T^{-2}]$ (4) $[M^2 L^2 T^{-3}]$

11. Two vectors $\vec{X}$ and $\vec{Y}$ have equal magnitude. The magnitude of $(\vec{X}-\vec{Y})$ is n times the magnitude of $(\vec{X}+\vec{Y})$. The angle between $\vec{X}$ and $\vec{Y}$ is :

(1) $\cos^{-1}\left(\frac{-n^2-1}{n^2-1}\right)$ (2) $\cos^{-1}\left(\frac{n^2-1}{-n^2-1}\right)$

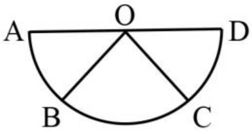
(3) $\cos^{-1}\left(\frac{n^2+1}{-n^2-1}\right)$ (4) $\cos^{-1}\left(\frac{n^2+1}{n^2-1}\right)$

12. **Assertion A :** If A, B, C, D are four points on a semi-circular arc with centre at 'O' such that $|\overrightarrow{AB}| = |\overrightarrow{BC}| = |\overrightarrow{CD}|$, then

$\overrightarrow{AB} + \overrightarrow{AC} + \overrightarrow{AD} = 4\,\overrightarrow{AO} + \overrightarrow{OB} + \overrightarrow{OC}$

Reason R : Polygon law of vector addition yields

$\overrightarrow{AB} + \overrightarrow{BC} + \overrightarrow{CD} = \overrightarrow{AD} = 2\,\overrightarrow{AO}$



In the light of the above statements, choose the **most appropriate** answer from the options given below :

(1) **A** is correct but **R** is not correct.

(2) **A** is not correct but **R** is correct.

(3) Both **A** and **R** are correct and **R** is the correct explanation of **A**.

(4) Both **A** and **R** are correct but **R** is not the correct explanation of **A**.

SOLUTION

13. **Assertion A :** If in five complete rotations of the circular scale, the distance travelled on main scale of the screw gauge is 5 mm and there are 50 total divisions on circular scale, then least count is 0.001 cm.

Reason R :

$$\text{Least Count} = \frac{\text{Pitch}}{\text{Total divisions on circular scale}}$$

In the light of the above statements, choose the most appropriate answer from the options given below :

(1) **A** is not correct but **R** is correct.

(2) Both **A** and **R** are correct and **R** is the correct explanation of **A**.

(3) **A** is correct but **R** is not correct.

(4) Both **A** and **R** are correct and **R** is NOT the correct explanation of **A**.

14. Match **List I** with **List II**.

List-I	**List-II**
(a) Capacitance, C	(i) $M^1L^1T^{-3}A^{-1}$
(b) Permittivity of free space, ε_0	(ii) $M^{-1}L^{-3}T^4A^2$
(c) Permeability of free space, μ_0	(iii) $M^{-1}L^{-2}T^4A^2$
(d) Electric field, E	(iv) $M^1L^1T^{-2}A^{-2}$

Choose the correct answer from the options given below

(1) (a) → (iii), (b) → (ii), (c) → (iv), (d) → (i)

(2) (a) → (iii), (b) → (iv), (c) → (ii), (d) → (i)

(3) (a) → (iv), (b) → (ii), (c) → (iii), (d) → (i)

(4) (a) → (iv), (b) → (iii), (c) → (ii), (d) → (i)

15. A physical quantity 'y' is represented by the formula $y = m^2 r^{-4} g^x l^{-\frac{3}{2}}$

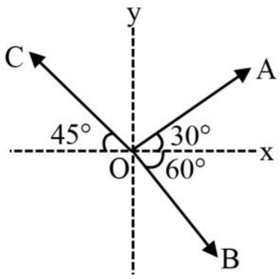
If the percentage errors found in y, m, r, l and g are 18, 1, 0.5, 4 and p respectively, then find the value of x and p.

(1) 5 and ± 2 (2) 4 and ± 3

(3) $\frac{16}{3}$ and $\pm \frac{3}{2}$ (4) 8 and ± 2

August Attempt

1. The magnitude of vectors $\overrightarrow{OA}$, $\overrightarrow{OB}$ and $\overrightarrow{OC}$ in the given figure are equal. The direction of $\overrightarrow{OA}+\overrightarrow{OB}-\overrightarrow{OC}$ with x-axis will be :-



(1) $\tan^{-1}\frac{(1-\sqrt{3}-\sqrt{2})}{(1+\sqrt{3}+\sqrt{2})}$ (3) $\tan^{-1}\frac{(\sqrt{3}-1+\sqrt{2})}{(1-\sqrt{3}+\sqrt{2})}$

(2) $\tan^{-1}\frac{(\sqrt{3}-1+\sqrt{2})}{(1+\sqrt{3}-\sqrt{2})}$ (4) $\tan^{-1}\frac{(1+\sqrt{3}-\sqrt{2})}{(1-\sqrt{3}-\sqrt{2})}$

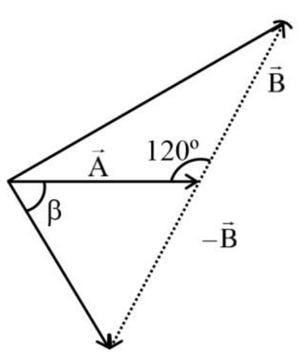
2. In a Screw Gauge, fifth division of the circular scale coincides with the reference line when the ratchet is closed. There are 50 divisions on the circular scale, and the main scale moves by 0.5 mm on a complete rotation. For a particular observation the reading on the main scale is 5 mm and the 20th division of the circular scale coincides with reference line. Calculate the true reading.

(1) 5.00 mm (2) 5.25 mm
(3) 5.15 mm (4) 5.20 mm

3. If E, L, M and G denote the quantities as energy, angular momentum, mass and constant of gravitation respectively, then the dimensions of P in the formula $P = EL^2M^{-5}G^{-2}$ are :-

(1) $[M^0 L^1 T^0]$ (2) $[M^{-1} L^{-1} T^2]$
(3) $[M^1 L^1 T^{-2}]$ (4) $[M^0 L^0 T^0]$

4. The angle between vector $(\vec{A})$ and $(\vec{A}-\vec{B})$ is :



(1) $\tan^{-1}\left(\frac{-\frac{B}{2}}{A-B\frac{\sqrt{3}}{2}}\right)$ (3) $\tan^{-1}\left(\frac{\sqrt{3}B}{2A-B}\right)$

(2) $\tan^{-1}\left(\frac{A}{0.7B}\right)$ (4) $\tan^{-1}\left(\frac{B\cos\theta}{A-B\sin\theta}\right)$

5. Match List–I with List–II.

	List-I		List-II
(a)	Magnetic Induction	(i)	$ML^2T^{-2}A^{-1}$
(b)	Magnetic Flux	(ii)	$M^0L^{-1}A$
(c)	Magnetic Permeability	(iii)	$MT^{-2}A^{-1}$
(d)	Magnetization	(iv)	$MLT^{-2}A^{-2}$

Choose the most appropriate answer from the options given below :

(1) (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)
(2) (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)
(3) (a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)
(4) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

6. If the length of the pendulum in pendulum clock increases by 0.1%, then the error in time per day is:

(1) 86.4 s
(2) 4.32 s
(3) 43.2 s
(4) 8.64 s

7. The acceleration due to gravity is found upto an accuracy of 4% on a planet. The energy supplied to a simple pendulum to known mass 'm' to undertake oscillations of time period T is being estimated. If time period is measured to an accuracy of 3%, the accuracy to which E is known as ....%

8. Which of the following is not a dimensionless quantity ?

(1) Relative magnetic permeability (μ_r)
(2) Power factor
(3) Permeability of free space (μ_0)
(4) Quality factor

SOLUTION

9. If E and H represents the intensity of electric field and magnetising field respectively, then the unit of E/H will be :

(1) ohm (2) mho

(3) joule (4) newton

10. Match List-I with List-II.

List-I	List-II
(a) R_H (Rydberg constant)	(i) kg m^{-1} s^{-1}
(b) h(Planck's constant)	(ii) kg m^2 s^{-1}
(c) μ_B (Magnetic field energy density)	(iii) m^{-1}
(d) η(coefficient of viscocity)	(iv) kg m^{-1} s^{-2}

Choose the most appropriate answer from the options given below :

(1) (a)–(ii), (b)–(iii), (c)–(iv), (d)–(i)

(2) (a)–(iii), (b)–(ii), (c)–(iv), (d)–(i)

(3) (a)–(iv), (b)–(ii), (c)–(i), (d)–(iii)

(4) (a)–(iii), (b)–(ii), (c)–(i), (d)–(iv)

11. If force (F), length (L) and time (T) are taken as the fundamental quantities. Then what will be the dimension of density :

(1)$[FL^{-4}T^2]$ (2) $[FL^{-3}T^2]$

(3) $[FL^{-5}T^2]$ (4) $[FL^{-3}T^3]$

12. Match **List-I** with **List-II**.

List-I	List-II
(a) Torque	(i) MLT^{-1}
(b) Impulse	(ii) MT^{-2}
(c) Tension	(iii) ML^2T^{-2}
(d) Surface Tension	(iv) MLT^{-2}

Choose the **most appropriate** answer from the option given below :

(1) (a)–(iii), (b)–(i), (c)–(iv), (d)–(ii)

(2) (a)–(ii), (b)–(i), (c)–(iv), (d)–(iii)

(3) (a)–(i), (b)–(iii), (c)–(iv), (d)–(ii)

(4) (a)–(iii), (b)–(iv), (c)–(i), (d)–(ii)

13. Which of the following equations is dimensionally incorrect ?

Where t = time, h = height, s = surface tension, θ = angle, ρ = density, a, r = radius, g = acceleration due to gravity, v = volume , p = pressure, W = work done, Γ = torque, ∈= permittivity, E = electric field, J = current density, L = length.

(1) $v = \frac{\pi p a^4}{8\eta L}$ (2) $h = \frac{2s\cos\theta}{\rho r g}$

(3) $J = \in \frac{\partial E}{\partial t}$ (4) $W = \Gamma\theta$

14. If velocity [V], time [T] and force [F] are chosen as the base quantities, the dimensions of the mass will be :

(1) $[FT^{-1}V^{-1}]$

(2) $[FTV^{-1}]$

(3) $[FT^2V]$

(4) $[FVT^{-1}]$

15. The diameter of a spherical bob is measured using a vernier callipers. 9 divisions of the main scale, in the vernier callipers, are equal to 10 divisions of vernier scale. One main scale division is 1 mm. The main scale reading is 10 mm and 8^{th} division of vernier scale was found to coincide exactly with one of the main scale division. If the given vernier callipers has positive zero error of 0.04 cm, then the radius of the bob is_____ $\times 10^{-2}$ cm.

SOLUTION

16. A student determined Young's Modulus of elasticity using the formula $Y = \frac{MgL^3}{4bd^3\delta}$. The value of g is taken to be 9.8 m/s^2, without any significant error, his observation are as following.

Physical Quantity	Least count of the Equipment used for measurement	Observed value
Mass (M)	1 g	2 kg
Length of bar (L)	1 mm	1 m
Breadth of bar (b)	0.1 mm	4 cm
Thickness of bar (d)	0.01 mm	0.4 cm
Depression (δ)	0.01 mm	5 mm

Then the fractional error in the measurement of Y is :

(1) 0.0083 (2) 0.0155

(3) 0.155 (4) 0.083

17. Two resistors $R_1 = (4 \pm 0.8)\ \Omega$ and $R_2 = (4 \pm 0.4)\ \Omega$ are connected in parallel. The equivalent resistance of their parallel combination will be :

(1) $(4 \pm 0.4)\ \Omega$

(2) $(2 \pm 0.4)\ \Omega$

(3) $(2 \pm 0.3)\ \Omega$

(4) $(4 \pm 0.3)\ \Omega$

SOLUTION

ANSWER KEY

Feb Attempt

1. 1
2. 2
3. 1
4. 180
5. 2
6. 2

March Attempt

1. 4
2. 5
3. 82
4. 4
5. 2
6. 2
7. 1
8. 34

July Attempt

1. 4
2. 4
3. 4
4. 4
5. 4
6. 3
7. 1
8. 2
9. 2
10. 13
11. 2
12. 4
13. 3
14. 1
15. 1

August Attempt

1. 1
2. 3
3. 4
4. 3
5. 1
6. 3
7. 4
8. 3
9. 14
10. 2
11. 1
12. 1
13. 2
14. 1
15. 52
16. 2
17. 3

1. Identify the pair of physical quantities which have different dimensions :
(A) Wave number and Rydberg's constant
(B) Stress and Coefficient of elasticity
(C) Coercivity and Magnetisation
(D) Specific heat capacity and Latent heat

2. Identify the pair of physical quantities that have same dimensions :
(A) velocity gradient and decay constant
(B) wien's constant and Stefan constant
(C) angular frequency and angular momentum
(D) wave number and Avogadro number

3. If $Z=\frac{A^2B^3}{C^4}$, then the relative error in Z will be :

(A) $\frac{\Delta A}{A}+\frac{\Delta B}{B}+\frac{\Delta C}{C}$

(B) $\frac{2\Delta A}{A}+\frac{3\Delta B}{B}-\frac{4\Delta C}{C}$

(C) $\frac{2\Delta A}{A}+\frac{3\Delta B}{B}+\frac{4\Delta C}{C}$

(D) $\frac{\Delta A}{A}+\frac{\Delta B}{B}-\frac{\Delta C}{C}$

4. $\vec{A}$ is a vector quantity such that $|\vec{A}|=$ non-zero constant. Which of the following expressions is true for $\vec{A}$?
(A) $\vec{A}.\vec{A}=0$ (B) $\vec{A}\times\vec{A}<0$
(C) $\vec{A}\times\vec{A}=0$ (D) $\vec{A}\times\vec{A}>0$

5. Which of the following relations is true for two unit vectors $\hat{A}$ and $\hat{B}$ making an angle θ to each other?

(A) $|\hat{A}+\hat{B}|=|\hat{A}-\hat{B}|\tan\frac{\theta}{2}$

(B) $|\hat{A}-\hat{B}|=|\hat{A}+\hat{B}|\tan\frac{\theta}{2}$

(C) $|\hat{A}+\hat{B}|=|\hat{A}-\hat{B}|\cos\frac{\theta}{2}$

(D) $|\hat{A}-\hat{B}|=|\hat{A}+\hat{B}|\cos\frac{\theta}{2}$

6. For $z=a^2x^3y^{\frac{1}{2}}$, where 'a' is a constant. If percentage error in measurement of 'x' and 'y' are 4% and 12%, respectively, then the percentage error for 'z' will be %.

7. An expression for a dimensionless quantity P is given by $P=\frac{\alpha}{\beta}\log_e\left(\frac{kt}{\beta x}\right)$; where α and β are constants, x is distance ; k is Boltzmann constant and t is the temperature. Then the dimensions of α will be :
(A) $[M^0L^{-1}T^0]$ (C) $[MLT^{-2}]$
(B) $[ML^0T^{-2}]$ (D) $[ML^2T^{-2}]$

8. In a vernier callipers, each cm on the main scale is divided into 20 equal parts. If tenth vernier scale division coincides with nineth main scale division. Then the value of vernier constant will be .... $\times 10^{-2}$ mm.

9. The dimension of mutual inductance is :
(A) $[ML^2T^{-2}A^{-1}]$ (B) $[ML^2T^{-3}A^{-1}]$
(C) $[ML^2T^{-2}A^{-2}]$ (D) $[ML^2T^{-3}A^{-2}]$

10. A travelling microscope is used to determine the refractive index of a glass slab. If 40 divisions are there in 1 cm on main scale and 50 Vernier scale divisions are equal to 49 main scale divisions, then least count of the travelling microscope is ______ $\times 10^{-6}$ m.

11. A sliver wire has mass (0.6 ± 0.006) g, radius (0.5 ± 0.005) mm and length (4 ± 0.04) cm. The maximum percentage error in the measurement of its density will be :
(A) 4% (B) 3%
(C) 6% (D) 7%

SOLUTION

12. The SI unit of a physical quantity is pascal-second. The dimensional formula of this quantity will be

(A) $[ML^{-1}T^{-1}]$ (B) $[ML^{-1}T^{-2}]$

(C) $[ML^{2}T^{-1}]$ (D) $[M^{-1}L^{3}T^{0}]$

13. The distance of the Sun from earth is 1.5×10^{11} m and its angular diameter is (2000) s when observed from the earth. The diameter of the Sun will be :

(A) 2.45×10^{10} m (B) 1.45×10^{10} m

(C) 1.45×10^{9} m (D) 0.14×10^{9} m

14. If L, C and R are the self inductance, capacitance and resistance respectively, which of the following does not have the dimension of time ?

(A) RC (B) $\frac{L}{R}$

(C) $\sqrt{LC}$ (D) $\frac{L}{C}$

15. Given below are two statements : One is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : Product of Pressure (P) and time (t) has the same dimension as that of coefficient of viscosity.

Reason R:

$$\text{Coefficient of viscosity} = \frac{\text{Force}}{\text{Velocity gradient}}$$

Question: Choose the correct answer from the options given below :

(A) Both A and R true, and R is correct explanation of A.

(B) Both A and R are true but R is NOT the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

SOLUTION

16. Velocity (v) and acceleration (a) in two systems of units 1 and 2 are related as $v_2 = \frac{n}{m^2} v_1$ and $a_2 = \frac{a_1}{mn}$ respectively. Here m and n are constants. The relations for distance and time in two systems respectively are:

(A) $\frac{n^3}{m^3} L_1 = L_2$ and $\frac{n^2}{m} T_1 = T_2$

(B) $L_1 = \frac{n^4}{m^2} L_2$ and $T_1 = \frac{n^2}{m} T_2$

(C) $L_1 = \frac{n^2}{m} L_2$ and $T_1 = \frac{n^4}{m^2} T_2$

(D) $\frac{n^2}{m} L_1 = L_2$ and $\frac{n^4}{m^2} T_1 = T_2$

17. A student in the laboratory measures thickness of a wire using screw gauge. The readings are 1.22 mm, 1.23 mm, 1.19 mm and 1.20 mm. The percentage error is $\frac{x}{121}\%$. The value of x is ___

18. In Vander Waals equation $\left[P + \frac{a}{V^2}\right][V - b] = RT$; P is pressure, V is volume, R is universal gas constant and T is temperature. The ratio of constants $\frac{a}{b}$ is dimensionally equal to :

(A) $\frac{P}{V}$ (B) $\frac{V}{P}$

(C) PV (D) PV^3

19. Two vectors $\vec{A}$ and $\vec{B}$ have equal magnitudes. If magnitude of $\vec{A}+\vec{B}$ is equal to two times the magnitude of $\vec{A}-\vec{B}$, then the angle between $\vec{A}$ and $\vec{B}$ will be :

(A) $\sin^{-1}\left(\frac{3}{5}\right)$ (B) $\sin^{-1}\left(\frac{1}{3}\right)$

(C) $\cos^{-1}\left(\frac{3}{5}\right)$ (D) $\cos^{-1}\left(\frac{1}{3}\right)$

20. The vernier constant of Vernier callipers is 0.1 mm and it has zero error of (–0.05) cm. While measuring diameter of a sphere, the main scale reading is 1.7 cm and coinciding vernier division is 5. The corrected diameter will be_____ $\times 10^{-2}$ cm.

SOLUTION

U&D, Errors & Vectors

1. D
2. A
3. C
4. C
5. B
6. 18
7. C
8. 5
9. C
10. 5
11. A
12. A
13. C
14. D
15. C
16. A
17. 150
18. C
19. C
20. 180

1. If momentum [P], area [A] and time [T] are taken as fundamental quantities, then the dimensional formula for coefficient of viscosity is :
(A) $[P A^{-1} T^0]$ (B) $[P A T^{-1}]$
(C) $[P A^{-1} T]$ (D) $[P A^{-1} T^{-1}]$

2. Which of the following physical quantities have the same dimensions ?
(A) Electric displacement ($\vec{D}$) and surface charge density
(B) Displacement current and electric field
(C) Current density and surface charge density
(D) Electric potential and energy

3. The maximum error in the measurement of resistance, current and time for which current flows in an electrical circuit are $1\%, 2\%$ and 3% respectively. The maximum percentage error in the detection of the dissipated heat will be:
(A) 2 (B) 4
(C) 6 (D) 8

4. A screw gauge of pitch 0.5mm is used to measure the diameter of uniform wire of length 6.8cm, the main scale reading is 1.5 mm and circular scale reading is 7. The calculated curved surface area of wire to appropriate significant figures is :
[Screw gauge has 50 divisions on the circular scale]
(A) $6.8 cm^2$ (B) $3.4 cm^2$
(C) $3.9 cm^2$ (D) $2.4 cm^2$

5. In an experiment of determine the Young's modulus of wire of a length exactly 1m, the extension in the length of the wire is measured as 0.4mm with an uncertainty of ± 0.02 mm when a load of 1kg is applied. The diameter of the wire is measured as 0.4mm with an uncertainty of ± 0.01 mm. The error in the measurement of Young's modulus (ΔY) is found to be $x \times 10^{10} Nm^{-2}$. The value of x is _____
[Take $g = 10 m/s^2$]

6. In a Vernier Calipers. 10 divisions of Vernier scale is equal to the 9 divisions of main scale. When both jaws of Vernier calipers touch each other, the zero of the Vernier scale is shifted to the left of zero of the main scale and 4^{th} Vernier scale division exactly coincides with the main scale reading. One main scale division is equal to 1 mm. While measuring diameter of a spherical body, the body is held between two jaws. It is now observed that zero of the Vernier scale lies between 30 and 31 divisions of main scale reading and 6^{th} Vernier scale division exactly. coincides with the main scale reading. The diameter of the spherical body will be :
(A) 3.02 cm (B) 3.06 cm
(C) 3.10 cm (D) 3.20 cm

7. If $\vec{A} = (2\hat{i} + 3\hat{j} - \hat{k})$ m and $\vec{B} = (\hat{i} + 2\hat{j} + 2\hat{k})$ m. The magnitude of component of vector $\vec{A}$ along vector $\vec{B}$ will be________ m.

8. A torque meter is calibrated to reference standards of mass, length and time each with 5% accuracy. After calibration, the measured torque with this torque meter will have net accuracy of :
(A) 15% (B) 25%
(C) 75% (D) 5%

SOLUTION

9. The one division of main scale of vernier callipers reads 1 mm and 10 divisions of Vernier scale is equal to the 9 divisions on main scale. When the two jaws of the instrument touch each other the zero of the Vernier lies to the right of zero of the main scale and its fourth division coincides with a main scale division. When a spherical bob is tightly placed between the two jaws, the zero of the Vernier scale lies in between 4.1 cm and 4.2 cm and 6^{th} Vernier division coincides with a main scale division. The diameter of the bob will be_____ 10^{-2} cm

10. An expression of energy density is given by $u=\frac{\alpha}{\beta}\sin\left(\frac{\alpha x}{kt}\right)$, where α, β are constants, x is displacement, k is Boltzmann constant and t is the temperature. The dimensions of β will be :

(A) $[ML^2T^{-2}\theta^{-1}]$
(B) $[M^0L^2T^{-2}]$
(C) $[M^0L^0T^0]$
(D) $[M^0L^2T^0]$

11. The dimensions of $\left(\frac{B^2}{\mu_0}\right)$ will be :

(if μ_0 : permeability of free space and

B : magnetic field)

(A) $[M L^2 T^{-2}]$
(B) $[M L T^{-2}]$
(C) $[M L^{-1} T^{-2}]$
(D) $[M L^2 T^{-2} A^{-1}]$

12. If the projection of $2\hat{i}+4\hat{j}-2\hat{k}$ on $\hat{i}+2\hat{j}+\alpha\hat{k}$ is zero. Then, the value of α will be

13. Consider the efficiency of Carnot's engine is given by $\eta=\frac{\alpha\beta}{\sin\theta}\log_e\frac{\beta x}{kT}$, where α and β are constants.

If T is temperature, k is Boltzman constant, θ is angular displacement and x has the dimensions of length. Then, choose the **incorrect** option.

(A) Dimensions of β is same as that of force.
(B) Dimensions of α^{-1} x is same as that of energy.
(C) Dimensions of $\eta^{-1}\sin\theta$ is same as that of αβ
(D) Dimensions of α is same as that of β

14. In an experiment to find acceleration due to gravity (g) using simple pendulum, time period of 0.5 s is measured from time of 100 oscillation with a watch of 1s resolution. If measured value of length is 10 cm known to 1mm accuracy. The accuracy in the determination of g is found to be x %. The value of x is

15. Given below are two statements : One is labelled as Assertion (A) and other is labelled as Reason (R).

Assertion (A) : Time period of oscillation of a liquid drop depends on surface tension (S), if density of the liquid is p and radius of the drop is r, then $T = k\sqrt{pr^3/s^{3/2}}$ is dimensionally correct, where K is dimensionless.

Reason (R) : Using dimensional analysis we get R.H.S. having different dimension than that of time period.

In the light of above statements, choose the correct answer from the options given below.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A)
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A)
(C) (A) is true but (R) is false
(D) (A) is false but (R) is true

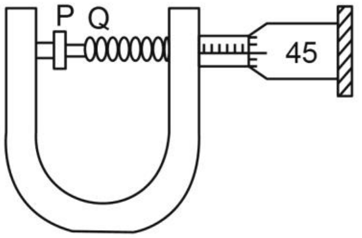
SOLUTION

16. A travelling microscope has 20 divisions per cm on the main scale while its Vernier scale has total 50 divisions and 25 Vernier scale divisions are equal to 24 main scale divisions, what is the least count of the travelling microscope ?

(A) 0.001 cm (B) 0.002 mm

(C) 0.002 cm (D) 0.005 cm

17. In an experiment to find out the diameter of wire using screw gauge, the following observation were noted :



(a) Screw moves 0.5 mm on main scale in one complete rotation

(b) Total divisions on circular scale = 50

(c) Main scale reading is 2.5 mm

(d) 45^{th} division of circular scale is in the pitch line

(e) Instrument has 0.03 mm negative error

Then the diameter of wire is :

(A) 2.92 mm (B) 2.54 mm

(C) 2.98 mm (D) 3.45 mm

18. Match List I with List II.

List I		List II	
A.	Torque	I.	Nms^{-1}
B.	Stress	II.	$J\,kg^{-1}$
C.	Latent Heat	III.	Nm
D.	Power	IV.	Nm^{-2}

Choose the correct answer from the options given below:

(A) A-III, B-II, C-I, D-IV

(B) A-III, B-IV, C-II, D-I

(C) A-IV, B-I, C-III, D-II

(D) A-II, B-III, C-I, D-IV

SOLUTION

ANSWER KEY

1. A
2. A
3. D
4. B
5. 2
6. C
7. 2
8. B
9. 412
10. D
11. C
12. 5
13. D
14. 5
15. D
16. C
17. C
18. B

1. $\left(P+\frac{a}{V^2}\right)(V-b)=RT$ represents the equation of state of some gases. Where P is the pressure, V is the volume, T is the temperature and a, b, R are the constants. The physical quantity, which has dimensional formula as that of $\frac{b^2}{a}$, will be :

(1) Bulk modulus (2) Modulus of rigidity
(3) Compressibility (4) Energy density

2. If the velocity of light c, universal gravitational constant G and planck's constant h are chosen as fundamental quantities. The dimensions of mass in the new system is:

(1) $\left[h^{\frac{1}{2}}c^{-\frac{1}{2}}G^{1}\right]$ (2) $\left[h^{1}c^{1}G^{-1}\right]$
(3) $\left[h^{-\frac{1}{2}}c^{\frac{1}{2}}G^{\frac{1}{2}}\right]$ (4) $\left[h^{\frac{1}{2}}c^{\frac{1}{2}}G^{-\frac{1}{2}}\right]$

3. Match List I with List II

LIST I		LIST II	
A.	Planck's constant (h)	I.	$[M^1 L^2 T^{-2}]$
B.	Stopping potential (Vs)	II.	$[M^1 L^1 T^{-1}]$
C.	Work function (Ø)	III.	$[M^1 L^2 T^{-1}]$
D.	Momentum (p)	IV.	$[M^1 L^2 T^{-3} A^{-1}]$

(1) A-III, B-I, C-II, D-IV
(2) A-III, B-IV, C-I, D-II
(3) A-II, B-IV, C-III, D-I
(4) A-I, B-III, C-IV, D-II

4. Vectors $a\hat{i}+b\hat{j}+\hat{k}$ and $2\hat{i}-3\hat{j}+4\hat{k}$ are perpendicular to each other when 3a + 2b = 7, the ratio of a to b is $\frac{x}{2}$. The value of x is _______ .

5. The frequency (ν) of an oscillating liquid drop may depend upon radius (r) of the drop, density (ρ) of liquid and the surface tension (s) of the liquid as : $\nu = r^a \rho^b s^c$. The values of a, b and c respectively are

(1) $\left(-\frac{3}{2},-\frac{1}{2},\frac{1}{2}\right)$ (2) $\left(\frac{3}{2},-\frac{1}{2},\frac{1}{2}\right)$
(3) $\left(\frac{3}{2},\frac{1}{2},-\frac{1}{2}\right)$ (4) $\left(-\frac{3}{2},\frac{1}{2},\frac{1}{2}\right)$

6. If two vectors $\vec{P}=\hat{i}+2m\hat{j}+m\hat{k}$ and $\vec{Q}=4\hat{i}-2\hat{j}+m\hat{k}$ are perpendicular to each other. Then, the value of m will be :

(1) 1
(2) –1
(3) – 3
(4) 2

7. Match List I with List II

List – I		List - II	
A	Surface tension	I.	$Kg\ m^{-1}\ s^{-1}$
B	Pressure	II.	$Kg\ ms^{-1}$
C	Viscosity	III.	$Kg\ m^{-1}\ s^{-2}$
D	Impulse	IV.	$Kg\ s^{-2}$

Choose the correct answer from the options given below :

(1) A-IV, B-III, C- II, D- I
(2) A-IV, B-III, C-I, D-II
(3) A-III, B-IV, C-I, D-II
(4) A-II, B-I, C-III, D-IV

8. If $\vec{P}=3\hat{i}+\sqrt{3}\hat{j}+2\hat{k}$ and $\vec{Q}=4\hat{i}+\sqrt{3}\hat{j}+2.5\hat{k}$ then, The unit vector in the direction of $\vec{P}\times\vec{Q}$ is $\frac{1}{x}\left(\sqrt{3}\hat{i}+\hat{j}-2\sqrt{3}\hat{k}\right)$. The value of x is

9. Match List I with List II

List		List II	
A.	Young's Modulus (Y)	I.	$[M L^{-1} T^{-1}]$
B.	Co-efficient of Viscosity (η)	II.	$[M L^2 T^{-1}]$
C.	Planck's Constant (h)	III.	$[M L^{-1} T^{-2}]$
D.	Work Function (ϕ)	IV.	$[M L^2 T^{-2}]$

Choose the correct answer from the options given below:

(1) A-II, B-III, C-IV, D-I
(2) A-III, B-I, C-II, D-IV
(3) A-I, B-III, C-IV, D-II
(4) A-I, B-II, C-III, D-IV

SOLUTION

10.

List-I (Physical Quantity)		List-II (Dimensional Formula)	
A	Pressure gradient	I	$[M^0L^2T^{-2}]$
B	Energy density	II	$[M^1L^{-1}T^{-2}]$
C	Electric Field	III	$[M^1L^{-2}T^{-2}]$
D	Latent heat	IV	$[M^1L^1T^{-3}A^{-1}]$

Choose the **correct** answer from the options given below:

(1) A-III, B-II, C-I, D-IV

(2) A-II, B-III, C-IV, D-I

(3) A-III, B-II, C-IV, D-I

(4) A-II, B-III, C-I, D-IV

11. The equation of a circle is given by $x^2 + y^2 = a^2$, where a is the radius. If the equation is modified to change the origin other than (0, 0), then find out the correct dimensions of A and B in a new equation : $(x - At)^2 + \left(y - \frac{t}{B}\right)^2 = a^2$.

The dimensions of t is given as $[T^{-1}]$.

(1) $A = [L^{-1}T], B = [LT^{-1}]$

(2) $A = [LT], B = [L^{-1}T^{-1}]$

(3) $A = [L^{-1}T^{-1}], B = [LT^{-1}]$

(4) $A = [L^{-1}T^{-1}], B = [LT]$

12. In an experiment of measuring the refractive index of a glass slab using travelling microscope in physics lab, a student measures real thickness of the glass slab as 5.25 mm and apparent thickness of the glass slab as 5.00 mm. Travelling microscope has 20 divisions in one cm on main scale and 50 divisions on vernier scale is equal to 49 divisions on main scale. The estimated uncertainty in the measurement of refractive index of the slab is $\frac{x}{10} \times 10^{-3}$, where x is __________

13. Electric field in a certain region is given by $\vec{E} = \left(\frac{A}{x^2}\hat{i} + \frac{B}{y^3}\hat{j}\right)$. The SI unit of A and B are :

(1) $Nm^3C^{-1}; Nm^2C^{-1}$ (2) $Nm^2C^{-1}; Nm^3C^{-1}$

(3) $Nm^3C; Nm^2C$ (4) $Nm^2C; Nm^3C$

14. In a screw gauge, there are 100 divisions on the circular scale and the main scale moves by 0.5 mm on a complete rotation of the circular scale. The zero of circular scale lies 6 divisions below the line of graduation when two studs are brought in contact with each other. When a wire is placed between the studs, 4 linear scale divisions are clearly visible while 46th division the circular scale coincide with the reference line. The diameter of the wire is $\_\_\_\_ \times 10^{-2}$ mm.

15. Match List I with List II.

	List I		List II
A	Torque	I.	$kg\ m^{-1}\ s^{-2}$
B	Energy density	II.	$kg\ ms^{-1}$
C	Pressure gradient	III.	$kg\ m^{-2}\ s^{-2}$
D	Impulse	IV.	$kg\ m^2\ s^{-2}$

Choose the **correct** answer from the options given below :

(1) A-IV, B-III, C-I, D-II

(2) A-I, B-IV, C-III, D-II

(3) A-IV, B-I, C-II, D-III

(4) A-IV, B-I, C-III, D-II

16. If R, X_L. and X_C represent resistance, inductive reactance and capacitive reactance. Then which of the following is dimensionless:

(1) $R X_L X_C$ (2) $\frac{R}{\sqrt{X_L X_C}}$

(3) $\frac{R}{X_L X_C}$ (4) $R\frac{X_L}{X_C}$

17. Match List-I with List-II.

	List-I		List-II
A.	Angular momentum	I	$[ML^2T^{-2}]$
B	Torque	II	$[ML^{-2}T^{-2}]$
C	Stress	III	$[ML^2T^{-1}]$
D	Pressure gradient	IV	$[ML^{-1}T^{-2}]$

Choose the correct answer from the options given below:

(1) A-I, B-IV, C-III, D-II

(2) A-III, B-I, C-IV, D-II

(3) A-II, B-III, C-IV, D-I

(4) A-IV, B-II, C-I, D-III

SOLUTION

Units Dimensions Errors Vectors

1. 3
2. 4
3. 2
4. 1
5. 1
6. 4
7. 2
8. 4
9. 2
10. 3
11. 2
12. 41
13. 2
14. 220
15. 4
16. 2
17. 2

1. Two resistances are given as $R_1 = (10 \pm 0.5)\Omega$ and $R_2 = (15 \pm 0.5)\Omega$. The percentage error in the measurement of equivalent resistance when they are connected in parallel is

(1) 6.33 (2) 2.33
(3) 4.33 (4) 5.33

2. Dimension of $\frac{1}{\mu_0 \epsilon_0}$ should be equal to

(1) T^2/L^2 (2) L/T
(3) L^2/T^2 (4) T/L

3. Two forces having magnitude A and $\frac{A}{2}$ are perpendicular to each other. The magnitude of their resultant is

(1) $\frac{\sqrt{5}A}{4}$ (2) $\frac{5A}{2}$
(3) $\frac{\sqrt{5}A^2}{2}$ (4) $\frac{\sqrt{5}A}{2}$

4. A cylindrical wire of mass (0.4 ± 0.01)g has length (8 ± 0.04)cm and radius (6 ± 0.03)mm. The maximum error in its density will be

(1) 1% (2) 3.5 %
(3) 4% (4) 5%

5.

LIST-I		LIST-II	
A.	Torque	I.	$ML^{-2}T^{-2}$
B.	Stress	II.	ML^2T^{-2}
C.	Pressure gradient	III.	$ML^{-1}T^{-1}$
D.	Coefficient of viscosity	IV.	$ML^{-1}T^{-2}$

Choose the correct answer from the options given below:

(1) A-III, B-IV, C-I, D-II
(2) A-IV, B-II, C-III, D-I
(3) A-II, B-IV, C-I, D-III
(4) A-II, B-I, C-IV, D-III

6. A physical quantity P is given as

$$P = \frac{a^2 b^3}{c\sqrt{d}}$$

The percentage error in the measurement of a, b, c and d are 1%, 2%, 3% and 4% respectively. The percentage error in the measurement of quantity P will be

(1) 13% (2) 14%
(3) 12% (4) 16%

7. In an experiment with Vernier callipers of least count 0.1 mm, when two jaws are joined together the zero of Vernier scale lies right to the zero of the main scale and 6^{th} division of Vernier scale coincides with the main scale division. While measuring the diameter of a spherical bob, the zero of vernier scale lies in between 3.2 cm and 3.3 cm marks, and 4^{th} division of vernier scale coincides with the main scale division. The diameter of bob is measured as :

(1) 3.18 cm
(2) 3.25 cm
(3) 3.26 cm
(4) 3.22 cm

8. Statements I : Astronomical unit (Au). Parsec (Pc) and Light year (ly) are units for measuring astronomical distances.

Statements II: Au < Parsec (Pc) < ly

In the light of the above statements. choose the most appropriate answer from the options given below:

(1) Both Statements I and Statements II are correct.
(2) Statements I is correct but Statements II is incorrect.
(3) Both Statements I and Statements II are incorrect.
(4) Statements I is incorrect but statements II is correct.

SOLUTION

9. If force (F), velocity (V) and time (T) are considered as fundamental physical quantity, then dimensional formula of density will be:

(1) $FV^{-2}T^{2}$ (2) $FV^{-4}T^{-2}$

(3) $FV^{4}T^{-6}$ (3) $F^{2}V^{-2}T^{6}$

10. When vector $\vec{A} = 2\hat{i} + 3\hat{j} + 2\hat{k}$ is subtracted from vector $\vec{B}$, it gives a vector equal to $2\hat{j}$. Then the magnitude of vector $\vec{B}$ will be:

(1) $\sqrt{13}$

(2) 3

(3) $\sqrt{6}$

(4) $\sqrt{5}$

11.

List I		List II	
A.	Spring constant	I.	(T^{-1})
B.	Angular speed	II.	(MT^{-2})
C.	Angular momentum	III.	(ML^{2})
D.	Moment of Inertia	IV.	$(ML^{2}T^{-1})$

Choose the correct answer from the options given below:

(1) A-II, B-I, C-IV, D-III

(2) A-IV, B-I, C-III, D-II

(3) A-II, B-III, C-I, D-IV

(4) A-I, B-III, C-II, D-IV

12. A body of mass (5 ± 0.5) kg is moving with a velocity of (20 ± 0.4) m/s. Its kinetic energy will be

(1) (1000 ± 140)J

(2) (1000 ± 0.14)J

(3) (500 ± 0.14)J

(4) (500 ± 140)J

13. **Assertion A :** A spherical body of radius (5 ± 0.1) mm having a particular density is falling through a liquid of constant density. The percentage error in the calculation of its terminal velocity is 4%.

Reason R : The terminal velocity of the spherical body falling through the liquid is inversely proportional to its radius.

In the light of the above statements, choose the ***correct*** answer from the options given below

(1) Both **A** and **R** are true but **R** is **NOT** the correct explanation of **A**

(2) Both **A** and **R** are true and **R** is the correct explanation of **A**

(3) **A** is false but **R** is true

(4) **A** is true but **R** is false

14. In the equation $\left[X + \frac{a}{Y^2}\right][Y - b] = RT$, X is pressure, Y is volume, R is universal gas constant and T is temperature. The physical quantity equivalent to the ratio $\frac{a}{b}$ is :

(1) Energy

(2) Impulse

(3) Pressure gradient

(4) Coefficient of viscosity

15. A vector in x-y plane makes an angle of 30° with y-axis The magnitude of y-component of vector is $2\sqrt{3}$. The magnitude of x-component of the vector will be :

(1) $\frac{1}{\sqrt{3}}$ (2) 6

(3) $\sqrt{3}$ (4) 2

SOLUTION

16. The speed of a wave produced in water is given by $\upsilon = \lambda^a g^b \rho^c$. Where λ, g and ρ are wavelength of wave, acceleration due to gravity and density of water respectively. The values of a, b and c respectively, are :

(1) $\frac{1}{2}, \frac{1}{2}, 0$
(2) 1, 1, 0
(3) 1, –1, 0
(4) $\frac{1}{2}, 0, \frac{1}{2}$

SOLUTION

U&D, Errors & Vectors

1. 3
2. 3
3. 4
4. 3
5. 3
6. 1
7. 1
8. 2
9. 2
10. Bonus (*answer will be root33*)
11. 1
12. 1
13. 4
14. 1
15. 4
16. 1

1. 10 divisions on the main scale of a Vernier calliper coincide with 11 divisions on the Vernier scale. If each division on the main scale is of 5 units, the least count of the instrument is :

(1) $\frac{1}{2}$ (2) $\frac{10}{11}$

(3) $\frac{50}{11}$ (4) $\frac{5}{11}$

2. The radius (r), length (l) and resistance (R) of a metal wire was measured in the laboratory as

$r = (0.35 \pm 0.05)$ cm

$R = (100 \pm 10)$ ohm

$l = (15 \pm 0.2)$ cm

The percentage error in resistivity of the material of the wire is :

(1) 25.6% (2) 39.9%

(3) 37.3% (4) 35.6%

3. The dimensional formula of angular impulse is :

(1) $[M L^{-2} T^{-1}]$

(2) $[M L^{2} T^{-2}]$

(3) $[M L T^{-1}]$

(4) $[M L^{2} T^{-1}]$

4.

List - I (Number)	List - II (Significant figure)
(A) 1001	(I) 3
(B) 010.1	(II) 4
(C) 100.100	(III) 5
(D) 0.0010010	(IV) 6

Choose the correct answer from the options given below :

(1) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

(2) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)

(3) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(4) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

5. Given below are two statements :

Statement (I) : Planck's constant and angular momentum have same dimensions.

Statement (II) : Linear momentum and moment of force have same dimensions.

In the light of the above statements, choose the correct answer from the options given below :

(1) Statement I is true but Statement II is false

(2) Both Statement I and Statement II are false

(3) Both Statement I and Statement II are true

(4) Statement I is false but Statement II is true

6. The equation of state of a real gas is given by $\left(P+\frac{a}{V^2}\right)(V-b)=RT$, where P, V and T are pressure. volume and temperature respectively and R is the universal gas constant. The dimensions of $\frac{a}{b^2}$ is similar to that of :

(1) PV (2) P

(3) RT (4) R

7. Given below are two statements : one is labelled as Assertion(A) and the other is labelled as Reason (R).

Assertion (A) : In Vernier calliper if positive zero error exists, then while taking measurements, the reading taken will be more than the actual reading.

Reason (R) : The zero error in Vernier Calliper might have happened due to manufacturing defect or due to rough handling.

In the light of the above statements, choose the correct answer from the options given below :

(1) Both (A) and (R) are correct and (R) is the correct explanation of (A)

(2) Both (A) and (R) are correct but (R) is not the correct explanation of (A)

(3) (A) is true but (R) is false

(4) (A) is false but (R) is true

8 The resistance $R=\frac{V}{I}$ where $V=(200\pm5)$ V and $I=(20\pm0.2)$ A, the percentage error in the measurement of R is :

(1) 3.5% (2) 7%

(3) 3% (4) 5.5%

9. A physical quantity Q is found to depend on quantities a, b, c by the relation $Q=\frac{a^4b^3}{c^2}$. The percentage error in a, b and c are 3%, 4% and 5% respectively. Then, the percentage error in Q is :

(1) 66% (2) 43%

(3) 34% (4) 14%

SOLUTION - CLICK

10. Match List-I with List-II.

	List-I		List-II
A.	Coefficient of viscosity	I.	$[M L^2T^{-2}]$
B.	Surface Tension	II.	$[M L^2T^{-1}]$
C.	Angular momentum	III.	$[M L^{-1}T^{-1}]$
D.	Rotational kinetic energy	IV.	$[M L^0T^{-2}]$

(1) A–II, B–I, C–IV, D–III
(2) A–I, B–II, C–III, D–IV
(3) A–III, B–IV, C–II, D–I
(4) A–IV, B–III, C–II, D–I

11 If 50 Vernier divisions are equal to 49 main scale divisions of a travelling microscope and one smallest reading of main scale is 0.5 mm, the Vernier constant of travelling microscope is:
(1) 0.1 mm
(2) 0.1 cm
(3) 0.01 cm
(4) 0.01 mm

12. If mass is written as $m = k\, c^P\, G^{-1/2}\, h^{1/2}$ then the value of P will be : (Constants have their usual meaning with k a dimensionless constant)
(1) 1/2 (2) 1/3
(3)2 (4) –1/3

13. A vector has magnitude same as that of $\vec{A} - = 3\hat{j} + 4\hat{j}$ and is parallel to $\vec{B} = 4\hat{i} + 3\hat{j}$. The x and y components of this vector in first quadrant are x and 3 respectively where x = _______.

14. A force is represented by $F = ax^2 + bt^{1/2}$

Where x = distance and t = time. The dimensions of b^2/a are :

(1) $[ML^3T^{-3}]$ (2) $[MLT^{-2}]$
(3) $[ML^{-1}T^{-1}]$ (4) $[ML^2T^{-3}]$

15. The measured value of the length of a simple pendulum is 20 cm with 2 mm accuracy. The time for 50 oscillations was measured to be 40 seconds with 1 second resolution. From these measurements, the accuracy in the measurement of acceleration due to gravity is N%. The value of N is:
(1) 4 (2) 8
(3) 6 (4) 5

16. If two vectors $\vec{A}$ and $\vec{B}$ having equal magnitude R are inclined at an angle θ, then

(1) $\left|\vec{A} - \vec{B}\right| = \sqrt{2}\, R \sin\left(\frac{\theta}{2}\right)$

(2) $\left|\vec{A} + \vec{B}\right| = 2\, R \sin\left(\frac{\theta}{2}\right)$

(3) $\left|\vec{A} + \vec{B}\right| = 2\, R \cos\left(\frac{\theta}{2}\right)$

(4) $\left|\vec{A} - \vec{B}\right| = 2\, R \cos\left(\frac{\theta}{2}\right)$

17. Consider two physical quantities A and B related to each other as $E = \frac{B - x^2}{At}$ where E, x and t have dimensions of energy, length and time respectively. The dimension of AB is

(1) $L^{-2}M^1T^0$

(2) $L^2M^{-1}T^1$

(3) $L^{-2}M^{-1}T^1$

(4) $L^0M^{-1}T^1$

SOLUTION - CLICK

Answer Key

1. 4
2. 2
3. 4
4. 3
5. 1
6. 2
7. 2
8. 1
9. 3
10. 3
11. 4
12. 1
13. 4
14. 1
15. 3
16. 3
17. 2

SOLUTION - CLICK

1. In an experiment to measure focal length (f) of convex lens, the least counts of the measuring scales for the position of object (u) and for the position of image (v) are Δu and Δv, respectively. The error in the measurement of the focal length of the convex lens will be :

(1) $\frac{\Delta u}{u}+\frac{\Delta v}{v}$ (2) $f^2\left[\frac{\Delta u}{u^2}+\frac{\Delta v}{v^2}\right]$

(3) $2f\left[\frac{\Delta u}{u}+\frac{\Delta v}{v}\right]$ (4) $f\left[\frac{\Delta u}{u}+\frac{\Delta v}{v}\right]$

2. Applying the principle of homogeneity of dimensions, determine which one is correct.
where T is time period, G is gravitational constant, M is mass, r is radius of orbit.

(1) $T^2=\frac{4\pi^2 r}{GM^2}$

(2) $T^2=4\pi^2 r^3$

(3) $T^2=\frac{4\pi^2 r^3}{GM}$

(4) $T^2=\frac{4\pi^2 r^2}{GM}$

3. If G be the gravitational constant and u be the energy density then which of the following quantity have the dimension as that the $\sqrt{uG}$:

(1) Pressure gradient per unit mass

(2) Force per unit mass

(3) Gravitational potential

(4) Energy per unit mass

4. The angle between vector $\vec{Q}$ and the resultant of $(2\vec{Q}+2\vec{P})$ and $(2\vec{Q}-2\vec{P})$ is:

(1) 0° (2) $\tan^{-1}\frac{(2\vec{Q}-2\vec{P})}{2\vec{Q}+2\vec{P}}$

(3) $\tan^{-1}\left(\frac{P}{Q}\right)$ (4) $\tan^{-1}\left(\frac{2Q}{P}\right)$

5. Time periods of oscillation of the same simple pendulum measured using four different measuring clocks were recorded as 4.62 s, 4.632 s, 4.6 s and 4.64 s. The arithmetic mean of these reading in correct significant figure is.

(1) 4.623 s (2) 4.62 s

(3) 4.6 s (4) 5 s

6. What is the dimensional formula of ab^{-1} in the equation $\left(P+\frac{a}{V^2}\right)(V-b)=RT$, where letters have their usual meaning.

(1) $[M^0L^3T^{-2}]$

(2) $[ML^2T^{-2}]$

(3) $[M^{-1}L^5T^3]$

(4) $[M^6L^7T^4]$

7. A vernier callipers has 20 divisions on the vernier scale, which coincides with 19th division on the main scale. The least count of the instrument is 0.1 mm. One main scale division is equal to ____mm.

(1) 1 (2) 0.5

(3) 2 (4) 5

8. To find the spring constant (k) of a spring experimentally, a student commits 2% positive error in the measurement of time and 1% negative error in measurement of mass. The percentage error in determining value of k is :

(1) 3% (2) 1%

(3) 4% (4) 5%

9. While measuring diameter of wire using screw gauge the following readings were noted. Main scale reading is 1 mm and circular scale reading is equal to 42 divisions. Pitch of screw gauge is 1 mm and it has 100 divisions on circular scale. The diameter of the wire is $\frac{x}{50}$ mm . The value of x is :

(1) 142 (2) 71

(3) 42 (4) 21

SOLUTION - CLICK

10.

	LIST I		LIST II
A.	Torque	I.	$[M^1L^1T^{-2}A^{-2}]$
B.	Magnetic field	II.	$[L^2A^1]$
C.	Magnetic moment	III.	$[M^1T^{-2}A^{-1}]$
D.	Permeability of free space	IV.	$[M^1L^2T^{-2}]$

Choose the **correct** answer from the options given below :

(1) A-I, B-III, C-II, D-IV

(2) A-IV, B-III, C-II, D-I

(3) A-III, B-I, C-II, D-IV

(4) A-IV, B-II, C-III, D-I

11. For three vectors $\vec{A}=(-x\hat{i}-6\hat{j}-2\hat{k})$, $\vec{B}=(-\hat{i}+4\hat{j}+3\hat{k})$ and $\vec{C}=(-8\hat{i}-\hat{j}+3\hat{k})$, if $\vec{A}\cdot(\vec{B}\times\vec{C})=0$, them value of x is ________.

12. In finding out refractive index of glass slab the following observations were made through travelling microscope 50 vernier scale division = 49 MSD; 20 divisions on main scale in each cm

For mark on paper

MSR = 8.45 cm, VC = 26

For mark on paper seen through slab

MSR = 7.12 cm, VC = 41

For powder particle on the top surface of the glass slab

MSR = 4.05 cm, VC = 1

(MSR = Main Scale Reading, VC = Vernier Coincidence)

Refractive index of the glass slab is:

(1) 1.42 (2) 1.52

(3) 1.24 (4) 1.35

13. In a vernier calliper, when both jaws touch each other, zero of the vernier scale shifts towards left and its 4th division coincides exactly with a certain division on main scale. If 50 vernier scale divisions equal to 49 main scale divisions and zero error in the instrument is 0.04 mm then how many main scale divisions are there in 1 cm ?

(1) 40 (2) 5

(3) 20 (4) 10

14. **Statement (I) :** Dimensions of specific heat is $[L^2T^{-2}K^{-1}]$

Statement (II) : Dimensions of gas constant is $[M\,L^2T^{-1}K^{-1}]$

(1) Statement (I) is incorrect but statement (II) is correct

(2) Both statement (I) and statement (II) are incorrect

(3) Statement (I) is correct but statement (II) is incorrect

(4) Both statement (I) and statement (II) are correct

15. In an expression $a \times 10^b$:

(1) a is order of magnitude for $b \le 5$

(2) b is order of magnitude for $a \le 5$

(3) b is order of magnitude for $5 < a \le 10$

(4) b is order of magnitude for $a \ge 5$

16. Young's modulus is determined by the equation given by $Y = 49000\frac{m}{\ell}\frac{\text{dyne}}{\text{cm}^2}$ where M is the mass and ℓ is the extension of wire used in the experiment. Now error in Young modules(Y) is estimated by taking data from M-ℓ plot in graph paper. The smallest scale divisions are 5 g and 0.02 cm along load axis and extension axis respectively. If the value of M and ℓ are 500 g and 2 cm respectively then percentage error of Y is :

(1) 0.2 % (2) 0.02 %

(3) 2 % (4) 0.5 %

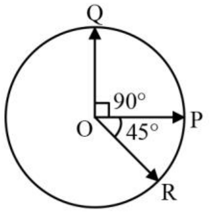
17. The diameter of a sphere is measured using a vernier caliper whose 9 divisions of main scale are equal to 10 divisions of vernier scale. The shortest division on the main scale is equal to 1 mm. The main scale reading is 2 cm and second division of vernier scale coincides with a division on main scale. If mass of the sphere is 8.635 g, the density of the sphere is:

(1) 2.5 g/cm^3 (2) 1.7 g/cm^3

(3) 2.2 g/cm^3 (4) 2.0 g/cm^3

SOLUTION - CLICK

18. Three vectors $\overrightarrow{OP}, \overrightarrow{OQ}$ and $\overrightarrow{OR}$ each of magnitude A are acting as shown in figure. The resultant of the three vectors is $A\sqrt{x}$. The value of x is _____.



19. If ϵ_0 is the permittivity of free space and E is the electric field, then $\epsilon_0 E^2$ has the dimensions :
(1) $[M^o L^{-2} T A]$ (2) $[M L^{-1} T^{-2}]$
(3) $[M^{-1} L^{-3} T^4 A^2]$ (4) $[M L^2 T^{-2}]$

20. There are 100 divisions on the circular scale of a screw gauge of pitch 1 mm. With no measuring quantity in between the jaws, the zero of the circular scale lies 5 divisions below the reference line. The diameter of a wire is then measured using this screw gauge. It is found the 4 linear scale divisions are clearly visible while 60 divisions on circular scale coincide with the reference line. The diameter of the wire is :
(1) 4.65 mm (2) 4.55 mm
(3) 4.60 mm (4) 3.35 mm

21. Least count of a vernier caliper is $\frac{1}{20N}$ cm. The value of one division on the main scale is 1 mm. Then the number of divisions of main scale that coincide with N divisions of vernier scale is :
(1) $\left(\frac{2N-1}{20N}\right)$ (2) $\left(\frac{2N-1}{2}\right)$
(3) $(2N - 1)$ (4) $\left(\frac{2N-1}{2N}\right)$

22. The dimensional formula of latent heat is:
(1) $[M^0LT^{-2}]$ (2) $[MLT^{-2}]$
(3) $[M^0L^2T^{-2}]$ (4) $[ML^2T^{-2}]$

23. One main scale division of a vernier caliper is equal to m units. If n^{th} division of main scale coincides with $(n + 1)^{th}$ division of vernier scale, the least count of the vernier caliper is:
(1) $\frac{n}{(n+1)}$ (2) $\frac{m}{(n+1)}$
(3) $\frac{1}{(n+1)}$ (4) $\frac{m}{n(n+1)}$

24. If $\vec{a}$ and $\vec{b}$ makes an angle $\cos^{-1}\left(\frac{5}{9}\right)$ with each other, then $|\vec{a}+\vec{b}| = \sqrt{2}|\vec{a}-\vec{b}|$ for $|\vec{a}| = n|\vec{b}|$
The integer value of n is _______.

25. The de-Broglie wavelength associated with a particle of mass m and energy E is $h/\sqrt{2mE}$. The dimensional formula for Planck's constant is :
(1) $[ML^{-1}T^{-2}]$ (2) $[ML^2T^{-1}]$
(3) $[MLT^{-2}]$ (4) $[M^2L^2T^{-2}]$

26. The resultant of two vectors $\vec{A}$ and $\vec{B}$ is perpendicular to $\vec{A}$ and its magnitude is half that of $\vec{B}$. The angle between vectors $\vec{A}$ and $\vec{B}$ is ………….

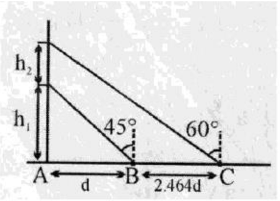
SOLUTION - CLICK

Answer Key

1. 2
2. 3
3. 2
4. 1
5. 3
6. 2
7. 3
8. 4
9. 2
10. 2
11. 4
12. 1
13. NTA gave option 3 (Correct Ans should be 230)
14. 3
15. 2
16. 3
17. 4
18. 3
19. 2
20. 2
21. 2
22. 3
23. 2
24. 3
25. 2
26. 150

SOLUTION - CLICK

1. A balloon is moving up in air vertically above a point A on the ground. When it is at a height h_1, a girl standing at a distance d (point B) from A (see figure) sees it at an angle $45°$ with respect to the vertical. When the balloon climbs up a further height h_2, it is seen at an angle $60°$ with respect to the vertical if the girl moves further by a distance $2.464d$ (point C). Then the height h_2 is (given $\tan 30° = 0.5774$):

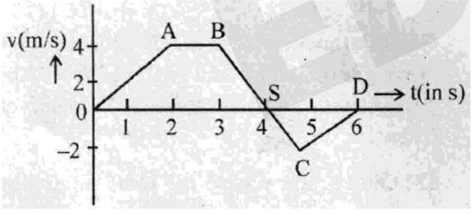


(a) d (b) $0.732d$
(c) $1.464d$ (d) $0.464d$

2. A helicopter rises from rest on the ground vertically upwards with a constant acceleration g. A food packet is dropped from the helicopter when it is a height h. The time taken by the packet to reach the ground is close to [g is the acceleration due to gravity]

(a) $t = \sqrt{\frac{2h}{3g}}$ (b) $t = 1.8\sqrt{\frac{h}{g}}$
(c) $t = 3.4\sqrt{\frac{h}{g}}$ (d) $t = \frac{2}{3}\sqrt{\frac{h}{g}}$

3. The velocity (v) and time (t) graph of a body in a straight line motion is shown in the figure. The point S is at 4.333 seconds. The total distance covered by the body in 6s is



(a) 12 m (b) 11 m
(c) $\frac{49}{4}$ m (d) $\frac{37}{3}$ m

4. Train A and train B are running on parallel tracks in the opposite directions with speeds of 36 km/hour and 72 km/hour, respectively. A person is walking in train A in the direction opposite to its motion with a speed of 1.8 km/hour. Speed (in ms^{-1}) of this person as observed from train B will be close to : (take the distance between the tracks as negligible)
(a) 30.5 ms^{-1} (b) 29.5 ms^{-1}
(c) 31.5 ms^{-1} (d) 28.5 ms^{-1}

5. A particle starts from the origin at $t = 0$ with an initial velocity of $3.0\hat{i}$ m/s and moves in the x-y plane with a constant acceleration $(6.0\hat{i} + 4.0\hat{j})\,\text{m/s}^2$. The x-coordinate of the particle at the instant when its y-coordinate is 32 m is D meters. The value of D is
(a) 60 (b) 50
(c) 32 (d) 40

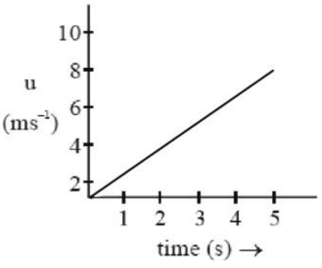
6. A particle moves such that its position vector $\vec{r}(t) = \cos\omega t\hat{i} + \sin\omega t\hat{j}$ where ω is a constant and t is time. Then which of the following statements is true for the velocity $\vec{v}(t)$ and acceleration $\vec{a}(t)$ of the particle
(a) $\vec{v}$ and $\vec{a}$ both are parallel to $\vec{r}$
(b) $\vec{v}$ is perpendicular to $\vec{r}$ and $\vec{a}$ is directed away from the origin
(c) $\vec{v}$ and $\vec{a}$ both are perpendicular to $\vec{r}$
(d) $\vec{v}$ is perpendicular to $\vec{r}$ and $\vec{a}$ is directed towards the origin

7. Starting from the origin at time $t = 0$, with initial velocity $5\hat{j}\,\text{ms}^{-1}$, a particle moves in the x-y plane with a constant acceleration of $(10\hat{i} + 4\hat{j})\,\text{ms}^{-2}$. At time t, its coordinates are (20 m, y_0 m). The values of t and y_0, are respectively
(a) 4s and 52 m (b) 2s and 24 m
(c) 2s and 18 m (d) 5s and 25 m

8. A clock has a continuously moving second's hand of 0.1 m length. The average acceleration of the tip of the hand (in units of ms^{-2}) is of the order of
(A) 10^{-3} (b) 10^{-2}
(c) 10^{-4} (d) 10^{-1}

9. A ball is dropped from the top of a 100 m high tower on a planet. In the last (1/2)s before hitting the ground, it covers a distance of 19 m. Acceleration due to gravity (in ms^{-2}) near the surface on that planet is

10. The speed verses time graph for a particle is shown in the figure. The distance travelled (in m) by the particle during the time interval $t = 0$ to $t = 5$s will be_____.



11. The distance x covered by a particle in one dimensional motion varies with time t as $x^2 = at^2 + 2bt + c$. If the acceleration of the particle depends on x as x^{-n}, where n is an integer, the value of n is

12. A particle is moving along the x-axis with its coordinate with time 't' given by $x(t) = 10 + 8t - 3t^2$. Another particle is moving along the y-axis with its coordinate as a function of time given by $y(t) = 5 - 8t^3$. At $t = 1$ s, the speed of the second particle as measured in the frame of the first particle is given as $\sqrt{v}$. Then v (in m^2/s^2) is _____ .

13. When a car is at rest, its driver sees rain drops falling on it vertically. When driving the car with speed v, he sees that rain drops are coming at an angle $60°$ from the horizontal. On further increasing the speed of the car to $(1+\beta)v$, this angle changes to $45°$. The value of β is close to
(a) 0.41 (b) 0.50
(c) 0.37 (d) 0.73

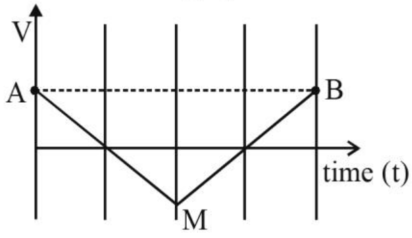
SOLUTION

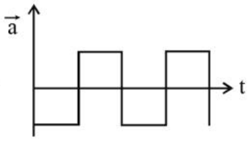
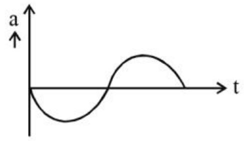
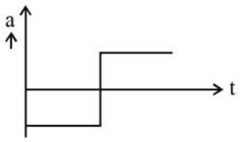
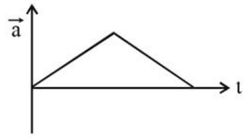
ANSWER KEY

1. a
2. c
3. d
4. b
5. a
6. d
7. c
8. a
9. 8
10. 20
11. 3
12. 580
13. d

Feb Attempt

1. If the velocity-time graph has the shape AMB, what would be the shape of the corresponding acceleration-time graph ?



(1) 
(3) 
(2) 
(4) 

2. A stone is dropped from the top of a building. When it crosses a point 5 m below the top, another stone starts to fall from a point 25 m below the top. Both stones reach the bottom of building simultaneously. The height of the building is :

(1) 35 m (2) 45m (3) 50 m (4) 25m

3. An engine of a train, moving with uniform acceleration, passes the signal-post with velocity u and the last compartment with velocity v. The velocity with which middle point of the train passes the signal post is:

(1) $\sqrt{\dfrac{v^2+u^2}{2}}$ (2) $\dfrac{v-u}{2}$

(3) $\dfrac{u+v}{2}$ (4) $\sqrt{\dfrac{v^2-u^2}{2}}$

4. The trajectory of a projectile in a vertical plane is $y = \alpha x - \beta x^2$, where α and β are constants and x & y are respectively the horizontal and vertical distances of the projectile from the point of projection. The angle of projection θ and the maximum height attained H are respectively given by :-

(1) $\tan^{-1}\alpha, \dfrac{\alpha^2}{4\beta}$ (2) $\tan^{-1}\beta, \dfrac{\alpha^2}{2\beta}$

(3) $\tan^{-1}\alpha, \dfrac{4\alpha^2}{\beta}$ (4) $\tan^{-1}\left(\dfrac{\beta}{\alpha}\right), \dfrac{\alpha^2}{\beta}$

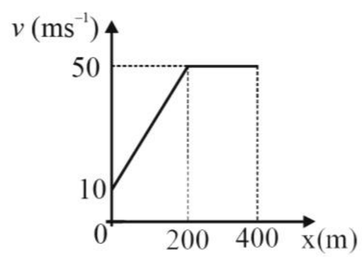
5. A scooter accelerates from rest for time t_1 at constant rate a_1 and then retards at constant rate a_2 for time t_2 and comes to rest. The correct value of $\dfrac{t_1}{t_2}$ will be :-

(1) $\dfrac{a_1+a_2}{a_2}$ (2) $\dfrac{a_2}{a_1}$

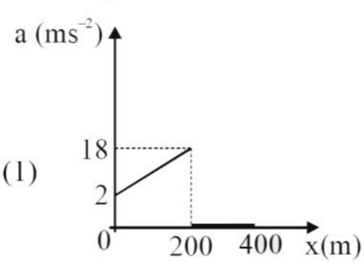
(3) $\dfrac{a_1}{a_2}$ (4) $\dfrac{a_1+a_2}{a_1}$

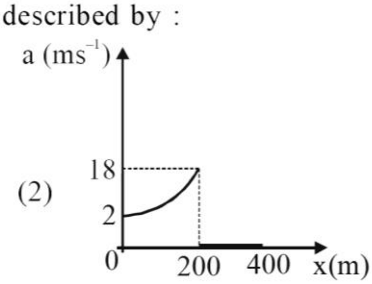
March Attempt

1. The velocity-displacement graph describing the motion of a bicycle is shown in the figure.

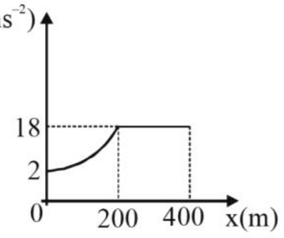


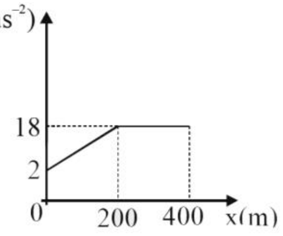
The acceleration-displacement graph of the bicycle's motion is best described by :

(1) 

(2) 

SOLUTION

(3) 

(4) 

2. A mosquito is moving with a velocity $\vec{v} = 0.5t^2\,\hat{i} + 3t\,\hat{j} + 9\hat{k}$ m/s and accelerating in uniform conditions. What will be the direction of mosquito after 2s ?

(1) $\tan^{-1}\left(\frac{2}{3}\right)$ from x-axis (3) $\tan^{-1}\left(\frac{5}{2}\right)$ from y-axis

(2) $\tan^{-1}\left(\frac{2}{3}\right)$ from y-axis (4) $\tan^{-1}\left(\frac{5}{2}\right)$ from x-axis

3. A swimmer can swim with velocity of 12 km/h in still water. Water flowing in a river has velocity 6 km/h. The direction with respect to the direction of flow of river water he should swim in order to reach the point on the other bank just opposite to his starting point is _________°. (Round off to the Nearest Integer) (find the angle in degree)

4. A car accelerates from rest at a constant rate α for some time after which it decelerates at a constant rate β to come to rest. If the total time elapsed is t seconds, the total distance travelled is :

(1) $\frac{4\alpha\beta}{(\alpha+\beta)}t^2$ (2) $\frac{2\alpha\beta}{(\alpha+\beta)}t^2$

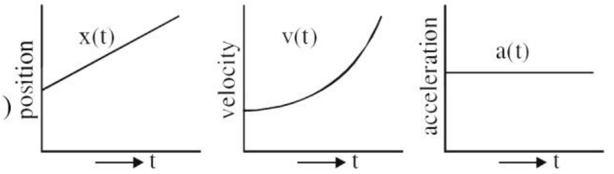
(3) $\frac{\alpha\beta}{2(\alpha+\beta)}t^2$ (4) $\frac{\alpha\beta}{4(\alpha+\beta)}t^2$

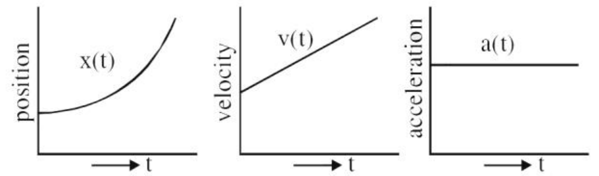
5. The velocity of a particle is $v = v_0 + gt + Ft^2$. Its position is x = 0 at t = 0 ; then its displacement after time (t = 1) is :

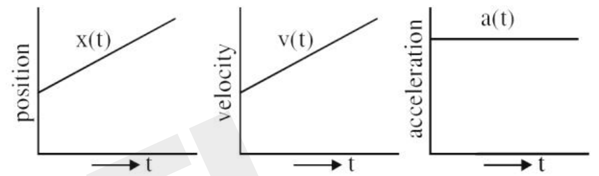
(1) $v_0 + g + F$ (2) $v_0 + \frac{g}{2} + \frac{F}{3}$

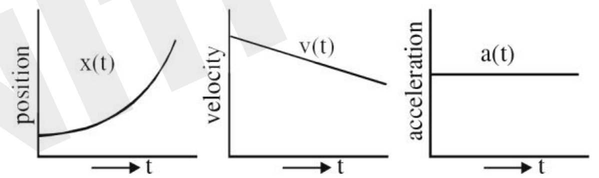
(3) $v_0 + \frac{g}{2} + F$ (4) $v_0 + 2g + 3F$

6. The position, velocity and acceleration of a particle moving with a constant acceleration can be represented by :

(1) 

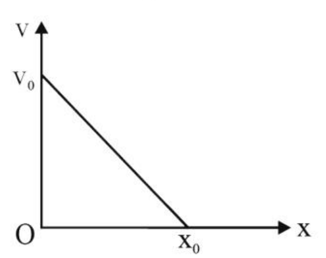
(2) 

(3) 

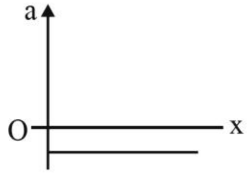
(4) 

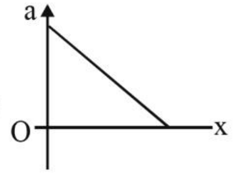
7. A person is swimming with a speed of 10 m/s at an angle of 120° with the flow and reaches to a point directly opposite on the other side of the river. The speed of the flow is 'x' m/s. The value of 'x' to the nearest integer is ______.

8. The velocity-displacement graph of a particle is shown in the figure.

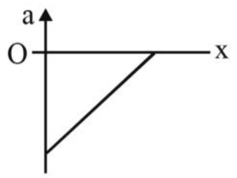


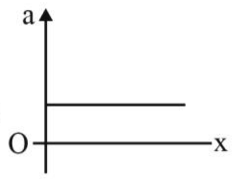
The acceleration-displacement graph of the same particle is represented by :

(1) 

(2) 

SOLUTION

(3) 

(4) 

July Attempt

1. A butterfly is flying with a velocity $4\sqrt{2}$ m/s in North-East direction. Wind is slowly blowing at 1 m/s from North to South. The resultant displacement of the butterfly in 3 seconds is :

(1) 3 m (2) 20 m

(3) $12\sqrt{2}$ m (4) 15 m

2. A boy reaches the airport and finds that the escalator is not working. He walks up the stationary escalator in time t_1. If he remains stationary on a moving escalator then the escalator takes him up in time t_2. The time taken by him to walk up on the moving escalator will be :

(1) $\frac{t_1 t_2}{t_2 - t_1}$ (2) $\frac{t_1 + t_2}{2}$ (3) $\frac{t_1 t_2}{t_2 + t_1}$ (4) $t_2 - t_1$

3. Water droplets are coming from an open tap at a particular rate. The spacing between a droplet observed at 4^{th} second after its fall to the next droplet is 34.3 m. At what rate the droplets are coming from the tap ? (Take $g = 9.8\ m/s^2$)

(1) 3 drops / 2 seconds

(2) 2 drops / second

(3) 1 drop / second

(4) 1 drop / 7 seconds

4. The relation between time t and distance x for a moving body is given as $t = mx^2 + nx$, where m and n are constants. The retardation of the motion is : (When v stands for velocity)

(1) $2\ mv^3$ (2) $2\ mnv^3$

(3) $2nv^3$ (4) $2n^2v^3$

5. A balloon was moving upwards with a uniform velocity of 10 m/s. An object of finite mass is dropped from the balloon when it was at a height of 75 m from the ground level. The height of the balloon from the ground when object strikes the ground was around :
(takes the value of g as $10\ m/s^2$)

(1) 300 m (2) 200 m

(3) 125 m (4) 250 m

6. The instantaneous velocity of a particle moving in a straight line is given as $v = \alpha t + \beta t^2$, where α and β are constants. The distance travelled by the particle between 1s and 2s is :

(1) $3\alpha + 7\beta$ (2) $\frac{3}{2}\alpha + \frac{7}{3}\beta$

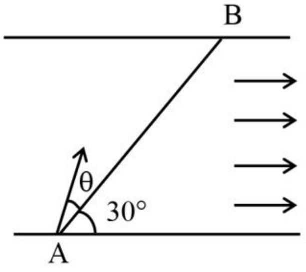
(3) $\frac{\alpha}{2} + \frac{\beta}{3}$ (4) $\frac{3}{2}\alpha + \frac{7}{2}\beta$

7. A ball is thrown up with a certain velocity so that it reaches a height 'h'. Find the ratio of the two different times of the ball reaching $\frac{h}{3}$ in both the directions.

(1) $\frac{\sqrt{2}-1}{\sqrt{2}+1}$ (2) $\frac{1}{3}$

(3) $\frac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$ (4) $\frac{\sqrt{3}-1}{\sqrt{3}+1}$

8. A swimmer wants to cross a river from point A to point B. Line AB makes an angle of 30° with the flow of river. Magnitude of velocity of the swimmer is same as that of the river. The angle θ with the line AB should be ____°, so that the swimmer reaches point B.



SOLUTION

August Attempt

1. Two spherical balls having equal masses with radius of 5 cm each are thrown upwards along the same vertical direction at an interval of 3s with the same initial velocity of 35 m/s, then these balls collide at a height of .... m. (Take $g = 10\ m/s^2$)

2. A bomb is dropped by fighter plane flying horizontally. To an observer sitting in the plane, the trajectory of the bomb is a :

(1) hyperbola

(2) parabola in the direction of motion of plane

(3) straight line vertically down the plane

(4) parabola in a direction opposite to the motion of plane

3. A huge circular arc of length 4.4 ly subtends an angle '4s' at the centre of the circle. How long it would take for a body to complete 4 revolution if its speed is 8 AU per second ?
Given : $1\ ly = 9.46 \times 10^{15}$ m
$1\ AU = 1.5 \times 10^{11}$ m
(1) 4.1×10^8 s (2) 4.5×10^{10} s
(3) 3.5×10^6 s (4) 7.2×10^8 s

4. If the velocity of a body related to displacement x is given by $\upsilon = \sqrt{5000 + 24x}$ m/s, then the acceleration of the body is ...... m/s^2.

5. Water drops are falling from a nozzle of a shower onto the floor, from a height of 9.8 m. The drops fall at a regular interval of time. When the first drop strikes the floor, at that instant, the third drop begins to fall. Locate the position of second drop from the floor when the first drop strikes the floor.

(1) 4.18 m (2) 2.94 m

(3) 2.45 m (4) 7.35 m

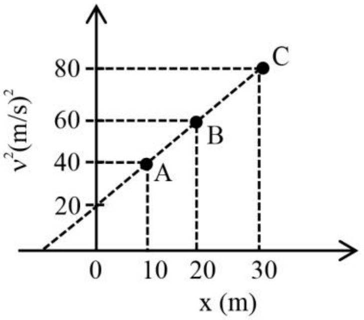
6. A player kicks a football with an initial speed of $25\ ms^{-1}$ at an angle of 45° from the ground. What are the maximum height and the time taken by the football to reach at the highest point during motion ? (Take $g = 10\ ms^{-2}$)
(1) $h_{max} = 10$ m $T = 2.5$ s
(2) $h_{max} = 15.625$ m $T = 3.54$ s
(3) $h_{max} = 15.625$ m $T = 1.77$ s
(4) $h_{max} = 3.54$ m $T = 0.125$ s

7. A helicopter is flying horizontally with a speed 'v' at an altitude 'h' has to drop a food packet for a man on the ground. What is the distance of helicopter from the man when the food packet is dropped?

(1) $\sqrt{\frac{2ghv^2+1}{h^2}}$ (2) $\sqrt{2ghv^2+h^2}$

(3) $\sqrt{\frac{2v^2h}{g}+h^2}$ (4) $\sqrt{\frac{2gh}{v^2}+h^2}$

8. A particle is moving with constant acceleration 'a'. Following graph shows v^2 versus x(displacement) plot. The acceleration of the particle is___m/s^2.



9. The ranges and heights for two projectiles projected with the same initial velocity at angles 42° and 48° with the horizontal are R_1, R_2 and H_1, H_2 respectively. Choose the correct option :
(1) $R_1 > R_2$ and $H_1 = H_2$ (2) $R_1 = R_2$ and $H_1 < H_2$
(3) $R_1 < R_2$ and $H_1 < H_2$ (4) $R_1 = R_2$ and $H_1 = H_2$

SOLUTION

ANSWER KEY

Feb Attempt

1. 2
2. 2
3. 1
4. 1
5. 2

March Attempt

1. Bonus
2. Bonus
3. 120
4. 3
5. 2
6. 2
7. 5
8. 3

July Attempt

1. 4
2. 3
3. 3
4. 1
5. 3
6. 2
7. 3
8. 30

August Attempt

1. 50
2. 3
3. 2
4. 12
5. 4
6. 3
7. 3
8. 1
9. 2

1. A projectile is projected with velocity of 25 m/s at an angle θ with the horizontal. After t seconds its inclination with horizontal becomes zero. If R represents horizontal range of the projectile, the value of θ will be : [use $g = 10\ m/s^2$]

(A) $\frac{1}{2}\sin^{-1}\left(\frac{5t^2}{4R}\right)$ (B) $\frac{1}{2}\sin^{-1}\left(\frac{4R}{5t^2}\right)$

(C) $\tan^{-1}\left(\frac{4t^2}{5R}\right)$ (D) $\cot^{-1}\left(\frac{R}{20t^2}\right)$

2. From the top of a tower, a ball is thrown vertically upward which reaches the ground in 6 s. A second ball thrown vertically downward from the same position with the same speed reaches the ground in 1.5 s. A third ball released, from the rest from the same location, will reach the ground in ________ s.

3. An object of mass 5 kg is thrown vertically upwards from the ground. The air resistance produces a constant retarding force of 10 N throughout the motion. The ratio of time of ascent to the time of descent will be equal to : [Use $g = 10\ ms^{-2}$]

(A) 1 : 1 (B) $\sqrt{2}:\sqrt{3}$

(C) $\sqrt{3}:\sqrt{2}$ (D) 2 : 3

4. A body is projected from the ground at an angle of 45° with the horizontal. Its velocity after 2s is $20\ ms^{-1}$. The maximum height reached by the body during its motion is _______m. (use $g = 10ms^{-2}$)

5. **Assertion A :** Two identical balls A and B thrown with same velocity 'u' at two different angles with horizontal attained the same range R. If A and B reached the maximum height h_1 and h_2 respectively, then $R = 4\sqrt{h_1h_2}$

Reason R: Product of said heights.

$$h_1h_2 = \left(\frac{u^2\sin^2\theta}{2g}\right)\cdot\left(\frac{u^2\cos^2\theta}{2g}\right)$$

Choose the CORRECT answer :

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is NOT the correct explanation of A.

(C) A is true but R is false

(D) A is false but R is true

6. Two buses P and Q start from a point at the same time and move in a straight line and their positions are represented by $X_P(t) = \alpha t + \beta t^2$ and $X_Q(t) = ft - t^2$. At what time, both the buses have same velocity ?

(A) $\frac{\alpha - f}{1+\beta}$ (B) $\frac{\alpha + f}{2(\beta - 1)}$

(C) $\frac{\alpha + f}{2(1+\beta)}$ (D) $\frac{f - \alpha}{2(1+\beta)}$

7. An object is thrown vertically upwards. At its maximum height, which of the following quantity becomes zero ?

(A) Momentum

(B) Potential energy

(C) Acceleration

(D) Force

SOLUTION

8. A fighter jet is flying horizontally at a certain altitude with a speed of 200 ms^{-1}. When it passes directly overhead an anti-aircraft gun, bullet is fired from the gun, at an angle θ with the horizontal, to hit the jet. If the bullet speed is 400 m/s, the value of θ will be .... °.

9. A ball of mass 0.5 kg is dropped from the height of 10m. The height, at which the magnitude of velocity becomes equal to the magnitude of acceleration due to gravity, is .... m. (Use g = 10 m/s^2).

10. A ball is projected vertically upward with an initial velocity of 50 ms^{-1} at t = 0s. At t = 2s. another ball is projected vertically upward with same velocity. At t =________s, second ball will meet the first ball (g =10 ms^{-2}).

11. A projectile is launched at an angle 'α' with the horizontal with a velocity 20 ms^{-1} . After 10 s, its inclination with horizontal is 'β'. The value of tanβ will be : (g = 10 ms^{-2})

(A) $\tan\alpha + 5\sec\alpha$ (B) $\tan\alpha - 5\sec\alpha$

(C) $2\tan\alpha - 5\sec\alpha$ (D) $2\tan\alpha + 5\sec\alpha$

12. A girl standing on road holds her umbrella at 45° with the vertical to keep the rain away. If she starts running without umbrella with a speed of $15\sqrt{2}\,kmh^{-1}$, the rain drops hit her head vertically. The speed of rain drops with respect to the moving girl is :

(A) $30\,kmh^{-1}$ (B) $\frac{25}{\sqrt{2}}\,kmh^{-1}$

(C) $\frac{30}{\sqrt{2}}\,kmh^{-1}$ (D) $25\,kmh^{-1}$

13. When a ball is dropped into a lake from a height 4.9 m above the water level, it hits the water with a velocity v and then sinks to the bottom with the constant velocity v. It reaches the bottom of the lake 4.0 s after it is dropped. The approximate depth of the lake is :

(A) 19.6 m (B) 29.4 m

(C) 39.2 m (D) 73.5 m

14. A car covers AB distance with first one–third at velocity v_1 ms^{-1}, second one–third at v_2 ms^{-1} and last one–third at v_3 ms^{-1}. If $v_3 = 3v_1$, $v_2 = 2v_1$ and $v_1 = 11$ ms^{-1} then the average velocity of the car is ________ ms^{-1}.

15. Two balls A and B are placed at the top of 180 m tall tower. Ball A is rele ased from the top at t = 0 s. Ball B is thrown vertically down with an initial velocity 'u' at t = 2 s. After a certain time, both balls meet 100 m above the ground. Find the value of 'u' in ms^{-1}. [use g = 10 ms^{-2}] :

(A) 10 (B) 15

(C) 20 (D) 30

16. A small toy starts moving from the position of rest under a constant acceleration. If it travels a distance of 10m in t s,. the distance travelled by the toy in the next t s will be :

(A) 10m (B) 20m

(C) 30m (D) 40m

17. A person can throw a ball upto a maximum range of 100 m. How high above the ground he can throw the same ball?

(A) 25 m (B) 50 m

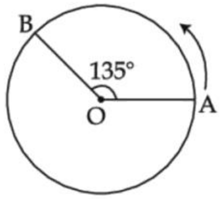
(C) 100 m (D) 200 m

SOLUTION

Answer Key

1. D
2. 3
3. B
4. 20
5. A
6. D
7. A
8. 60
9. 5
10. 6
11. B
12. C
13. B
14. 18
15. D
16. C
17. B

1. A person moved from A to B on a circular path as shown in figure. If the distance travelled by him is 60 m, then the magnitude of displacement would be : (Given $\cos 135° = -0.7$)



(A) 42 m (B) 47 m
(C) 19 m (D) 40 m

2. A car is moving with speed of 150 km/h and after applying the brake it will move 27 m before it stops. If the same car is moving with a speed of one third the reported speed then it will stop after travelling ________ m distance.

3. A ball is projected from the ground with a speed $15\ ms^{-1}$ at an angle θ with horizontal so that its range and maximum height are equal, then'$\tan\theta$' will be equal to

(A) $\frac{1}{4}$ (B) $\frac{1}{2}$
(C) 2 (D) 4

4. A particle is moving in a straight line such that its velocity is increasing at $5\ ms^{-1}$ per meter. The acceleration of the particle is _____ ms^{-2} at a point where its velocity is $20\ ms^{-1}$.

5. Two projectile thrown at 30^0 and 45^0 with the horizontal respectively, reach the maximum height in same time. The ratio of their initial velocities is

(A) $1:\sqrt{2}$ (B) 2 : 1
(C) $\sqrt{2}:1$ (D) $1:2$

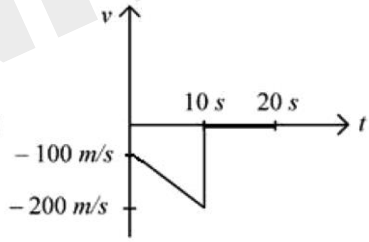
6. If the initial velocity in horizontal direction of a projectile is unit vector $\hat{i}$ and the equation of trajectory is $y = 5x(1-x)$. The y component vector of the initial velocity is _____ $\hat{j}$

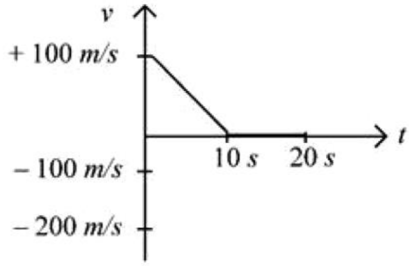
(Take $g = 10 m/s^2$)

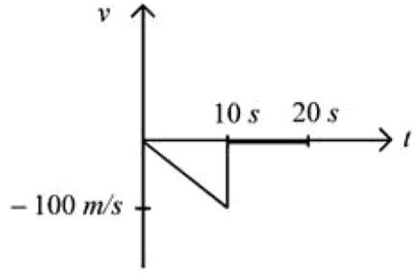
7. Two projectiles are thrown with same initial velocity making an angle of 45° and 30° with the horizontal respectively. The ratio of their respective ranges will be

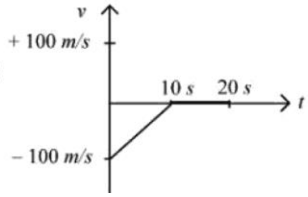
(A) $1:\sqrt{2}$ (B) $\sqrt{2}:1$
(C) $2:\sqrt{3}$ (D) $\sqrt{3}:2$

8. A bullet is shot vertically downwards with an initial velocity of 100 m/s from a certain height. Within 10 s, the bullet reaches the ground and instantaneously comes to rest due to the perfectly inelastic collision. The velocity-time curve for total time t = 20 s will be : (Take $g = 10\ m/s^2$)

(A)


(B)


(C)


(D)


SOLUTION

9. A ball of mass m is thrown vertically upward. Another ball of mass 2 m is thrown an angle θ with the vertical. Both the balls stay in air for the same period of time. The ratio of the heights attained by the two balls respectively is $\frac{1}{x}$. The value of x is _____ .

10. A body of mass 10 kg is projected at an angle of 45° with the horizontal. The trajectory of the body is observed to pass through a point (20, 10). If T is the time of flight, then its momentum vector, at time $t = \frac{T}{\sqrt{2}}$, is _________

[Take $g = 10\ m/s^2$]

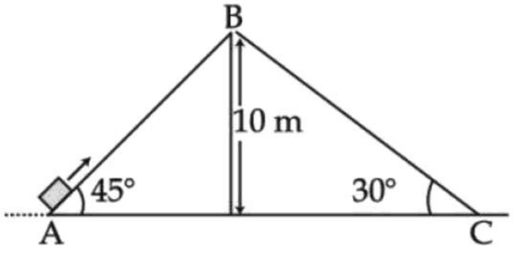
(A) $100\hat{i} + (100\sqrt{2} - 200)\hat{j}$

(B) $100\sqrt{2}\ \hat{i} + (100 - 200\sqrt{2})\hat{j}$

(C) $100\ \hat{i} + (100 - 200\sqrt{2})\hat{j}$

(D) $100\sqrt{2}\ \hat{i} + (100\sqrt{2} - 200)\hat{j}$

11. Two inclined planes are placed as shown in figure. A block is projected from the Point A of inclined plane AB along its surface with a velocity just sufficient to carry it to the top Point B at a height 10 m. After reaching the Point B the block slides down on inclined plane BC. Time it takes to reach to the point C from point A is $t(\sqrt{2}+1)$s. The value of t is……..(use $g = 10\ m/s^2$)



12. A NCC parade is going at a uniform speed of 9 km/h under a mango tree on which a monkey is sitting at a height of 19.6 m. At any particular instant, the monkey drops a mango. A cadet will receive the mango whose distance from the tree at time of drop is :

(Given $g = 9.8\ m/s^2$)

(A) 5 m (B) 10 m

(C) 19.8 m (D) 24.5 m

13. At time t = 0 a particle starts travelling from a height $7\hat{z}$ cm in a plane keeping z coordinate constant. At any instant of time it's position along the x and y directions are defined as 3t and $5t^3$ respectively. At t = 1s acceleration of the particle will be

(A) $-30y$ (B) $30y$

(C) $3x + 15y$ (D) $3x + 15y + 7\hat{z}$

14. A ball is thrown vertically upwards with a velocity of $19.6\ ms^{-1}$ from the top of a tower. The ball strikes the ground after 6 s. The height from the ground up to which the ball can rise will be $\left(\frac{k}{5}\right)$m. The value of k is ….. (use $g = 9.8\ m/s^2$)

15. A ball is thrown up vertically with a certain velocity so that, it reaches a maximum height h. Find the ratio of the times in which it is at height $\frac{h}{3}$ while going up and coming down respectively.

(A) $\frac{\sqrt{2}-1}{\sqrt{2}+1}$ (B) $\frac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$

(C) $\frac{\sqrt{3}-1}{\sqrt{3}+1}$ (D) $\frac{1}{3}$

SOLUTION

16. If $t=\sqrt{x}+4$, then $\left(\frac{dx}{dt}\right)_{t=4}$ is:

(A) 4 (B) Zero
(C) 8 (D) 16

17. An object is projected in the air with initial velocity u at an angle θ. The projectile motion is such that the horizontal range R, is maximum. Another object is projected in the air with a horizontal range half of the range of first object. The initial velocity remains same in both the case. The value of the angle of projection, at which the second object is projected, will be _______degree.

18. A juggler throws balls vertically upwards with same initial velocity in air. When the first ball reaches its highest position, he throws the next ball. Assuming the juggler throws n balls per second, the maximum height the balls can reach is

(A) g/2n (B) g/n
(C) 2gn (D) $g/2n^2$

19. A ball is released from a height h. If t_1 and t_2 be the time required to complete first half and second half of the distance respectively. Then, choose the correct relation between t_1 and t_2.

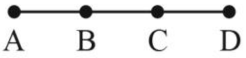
(A) $t_1=(\sqrt{2})t_2$ (B) $t_1=(\sqrt{2}-1)t_2$
(C) $t_2=(\sqrt{2}+1)t_1$ (D) $t_2=(\sqrt{2}-1)t_1$

SOLUTION

ANSWER KEY

1. B
2. 3
3. D
4. 100
5. C
6. 5
7. C
8. A
9. 1
10. D
11. 2
12. A
13. B
14. 392
15. B
16. B
17. 15
18. D
19. D

1. An object moves with speed v_1, v_2, and v_3 along a line segment AB, BC and CD respectively as shown in figure. Where AB = BC and AD = 3 AB, then average speed of the object will be :



(1) $\frac{(v_1+v_2+v_3)}{3}$

(2) $\frac{v_1v_2v_3}{3(v_1v_2+v_2v_3+v_3v_1)}$

(3) $\frac{3v_1v_2v_3}{v_1v_2+v_2v_3+v_3v_1}$

(4) $\frac{(v_1+v_2+v_3)}{3v_1v_2v_3}$

2. A child stands on the edge of the cliff 10 m above the ground and throws a stone horizontally with an initial speed of 5 ms^{-1}. Neglecting the air resistance, the speed with which the stone hits the ground will be _____ ms^{-1} (given, $g = 10\ ms^{-2}$).

(1) 20 (2) 15

(3) 30 (4) 25

3. For a body projected at an angle with the horizontal from the ground, choose the correct statement.

(1) Gravitational potential energy is maximum at the highest point.

(2) The horizontal component of velocity is zero at highest point.

(3) The vertical component of momentum is maximum at the highest point.

(4) The kinetic energy (K.E.) is zero at the highest point of projectile motion.

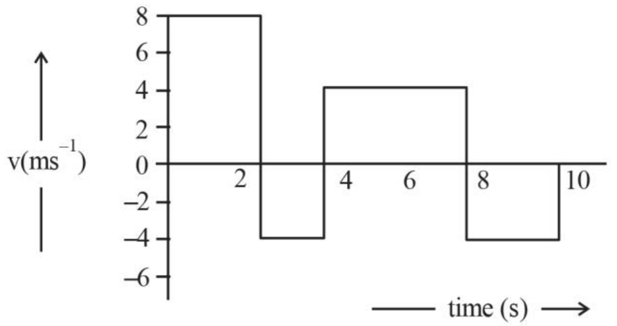
4. For a train engine moving with speed of 20 ms^{-1}. the driver must apply brakes at a distance of 500 m before the station for the train to come to rest at the station. If the brakes were applied at half of this distance, the train engine would cross the station with speed $\sqrt{x}\ ms^{-1}$. The value of x is ______ (Assuming same retardation is produced by brakes)

5. The maximum vertical height to which a man can throw a ball is 136 m. The maximum horizontal distance upto which he can throw the same ball is

(1) 192 m (2) 136 m

(3) 272 m (4) 68 m

6. The velocity time graph of a body moving in a straight line is shown in figure.



The ratio of displacement to distance travelled by the body in time 0 to 10s is

(1) 1:1 (2) 1:4

(3) 1:2 (4) 1:3

7. A car travels a distance of 'x' with speed V_1 and then same distance 'x' with speed V_2 in the same direction. The average speed of the car is:

(1) $\frac{v_1v_2}{2(v_1+v_2)}$ (2) $\frac{v_1+v_2}{2}$

(3) $\frac{2x}{v_1+v_2}$ (4) $\frac{2v_1v_2}{v_1+v_2}$

8. The distance travelled by a particle is related to time t as $x = 4t^2$. The velocity of the particle at t = 5s is .

(1) 40 ms^{-1} (2) 25 ms^{-1}

(3) 20 ms^{-1} (4) 8 ms^{-1}

9. Two objects are projected with same velocity 'u' however at different angles α and β with the horizontal. If α + β = 90°, the ratio of horizontal range of the first object to the 2nd object will be :

(1) 4 : 1 (2) 2 : 1

(3) 1 : 2 (4) 1 : 1

SOLUTION

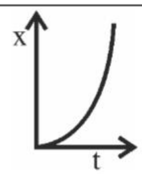
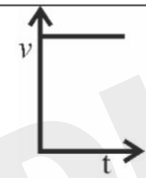
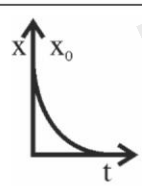
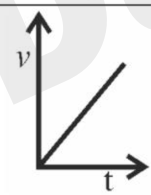
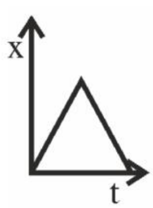
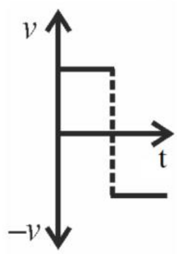
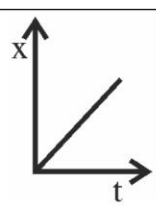
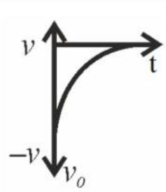
10. A stone is projected at angle 30^o to the horizontal. The ratio of kinetic energy of the stone at point of projection to its kinetic energy at the highest point of flight will be :

(1) 1 : 2 (2) 1 : 4

(3) 4 : 1 (4) 4 : 3

11. A tennis ball is dropped on to the floor from a height of 9.8 m. It rebounds to a height 5.0 m. Ball comes in contact with the floor for 0.2s. The average acceleration during contact is ____ ms^{-2}. [Given $g = 10\ ms^{-2}$]

12. Match Column-I with Column-II :

Column-I (x-t graphs)		Column-II (v-t graphs)	
A.		I.	
B.		II.	
C.		III.	
D.		IV.	

Choose the correct answer from the options given below:

(1) A- II B-IV, C-III, D-I

(2) A- I. B-II, C-III, D-IV

(3) A- II B-III, C-IV, D-I

(4) A- I, B-III. C-IV, D-II

13. A horse rider covers half the distance with 5 m/s speed. The remaining part of the distance was travelled with speed 10 m/s for half the time and with speed 15 m/s for other half of the time. The mean speed of the rider averaged over the whole time of motion is x/7 m/s. The value of x is

14. A vehicle travels 4 km with speed of 3 km/h and another 4 km with speed of 5 km/h, then its average speed is :

(1) 4.25 km/h (2) 3.50 km/h

(3) 4.00 km/h (4) 3.75 km/h

15. The initial speed of a projectile fired from ground is u. At the highest point during its motion, the speed of projectile is $\frac{\sqrt{3}}{2}u$. The time of flight of the projectile is:

(1) $\frac{u}{2g}$ (2) $\frac{u}{g}$

(3) $\frac{2u}{g}$ (4) $\frac{\sqrt{3}u}{g}$

16. The speed of a swimmer is 4 km h^{-1} in still water. If the swimmer makes his strokes normal to the flow of river of width 1 km, he reaches a point 750 m down the stream on the opposite bank.
The speed of the river water is _______ km h^{-1}.

17. Two bodies are projected from ground with same speeds 40 ms^{-1} at two different angles with respect to horizontal. The bodies were found to have same range. If one of the body was projected at an angle of 60°, with horizontal then sum of the maximum heights, attained by the two projectiles, is _______ m. (Given $g=10ms^{-2}$)

SOLUTION

Kinematics

1. 3
2. 2
3. 1
4. 200
5. 3
6. 4
7. 4
8. 1
9. 4
10. 4
11. 120
12. 1
13. 50
14. 4
15. 2
16. 3
17. 80

1. A particle is moving with constant speed in a circular path. When the particle turns by an angle 90°, the ratio of instantaneous velocity to its average velocity is $\pi : x\sqrt{2}$. The value of x will be

(1) 2 (2) 5
(3) 1 (4) 7

2. **Assertion A** and the other is labelled as **Reason R.**

Assertion A : When a body is projected at an angle 45°, it's range is maximum.

Reason R : For maximum range, the value of $\sin 2\theta$ should be equal to one.

In the light of the above statements, choose the **correct** answer from the options given below :

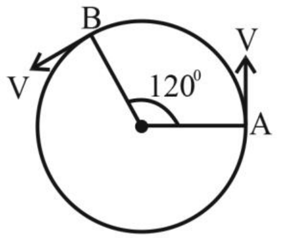
(1) Both **A** and **R** are correct but **R** is **NOT** the correct explanation of **A**

(2) Both **A** and **R** are correct **R** is the correct explanation of **A**

(3) **A** is true but **R** is false

(4) **A** is false but **R** is true

3. As shown in the figure, a particle is moving with constant speed π m/s. Considering its motion from A to B, the magnitude of the average velocity is:



(1) π m/s (2) $\sqrt{3}$ m/s
(3) $2\sqrt{3}$ m/s (4) $1.5\sqrt{3}$ m/s

4. A particle starts with an initial velocity of $10.0 ms^{-1}$ along x-direction and accelerates uniformly at the rate of $2.0\ ms^{-2}$. The time taken by the particle to reach the velocity of $60.0\ ms^{-1}$ is______.

(1) 6s (2) 3s
(3) 30s (4) 25s

5. Two projectiles A and B are thrown with initial velocities of 40 m/s and 60 m/s at angles 30° and 60° with the horizontal respectively. The ratio of their ranges respectively is (g= 10 m/s^2)

(1) $\sqrt{3}:2$ (2) $2:\sqrt{3}$
(3) 1 : 1 (4) 4 : 9

6. The trajectory of projectile, projected from the ground is given by $y = x - \frac{x^2}{20}$. Where x and y are measured in meter. The maximum height attained by the projectile will be.

(1) 5 m (2) $10\sqrt{2}$m
(3) 200 m (4) 10 m

7. **Statement I:** Area under velocity- time graph gives the distance travelled by the body in a given time.

Statement II: Area under acceleration- time graph is equal to the change in velocity- in the given time.

In the light of given statements, choose the correct answer from the options given below.

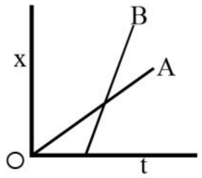
(1) Both Statement I and Statement II are true.
(2) Statement I is correct but Statement II is false.
(3) Statement I is incorrect but Statement II is true.
(4) Both Statement I and Statement II are False.

SOLUTION

8. The range of the projectile projected at an angle of 15° with horizontal is 50 m. If the projectile is projected with same velocity at an angle of 45° with horizontal, then its range will be :

(1) 50 m
(2) $50\sqrt{2}$ m
(3) 100 m
(4) $100\sqrt{2}$ m

9. The position-time graphs for two students A and B returning from the school to their homes are shown in figure :



(A) A lives closer to the school
(B) B lives closer to the school
(C) A takes lesser time to reach home
(D) A travels faster than B
(E) B travels faster than A

Choose the correct answer from the options given below :

(1) (A) and (E) only
(2) (B) and (E) only
(3) (A), (C) and (E) only
(4) (A), (C) and (D) only

10. A person travels x distance with velocity v_1 and then x distance with velocity v_2 in the same direction. The average velocity of the person is v, then the relation between v, v_1 and v_2 will be :

(1) $v = v_1 + v_2$

(2) $v = \frac{v_1 + v_2}{2}$

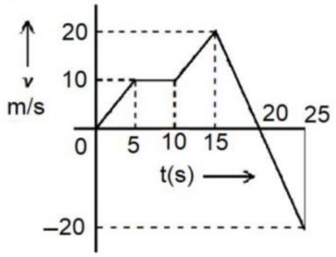
(3) $\frac{2}{v} = \frac{1}{v_1} + \frac{1}{v_2}$

(4) $\frac{1}{v} = \frac{1}{v_1} + \frac{1}{v_2}$

11. Two projectiles are projected at 30° and 60° with the horizontal with the same speed. The ratio of the maximum height attained by the two projectiles respectively is:

(1) $2:\sqrt{3}$
(2) $\sqrt{3}:1$
(3) 1 : 3
(4) $1:\sqrt{3}$

12. From the v - t graph shown. the ratio of distance to displacement in 25 s of motion



(1) $\frac{3}{5}$
(2) $\frac{1}{2}$
(3) $\frac{5}{3}$
(4) 1

13. A projectile fired at 30° to the ground is observed to be at same height at time 3s and 5s after projection, during its flight. The speed of projection of the projectile is ________ ms^{-1}

(Given g = 10 m s^{-2})

14. A projectile is projected at 30° from horizontal with initial velocity 40 ms^{-1}. The velocity of the projectile at t = 2 s from the start will be:

(Given g = 10 m/s^2)

(1) $20\sqrt{3}\,ms^{-1}$
(2) $40\sqrt{3}\,ms^{-1}$
(3) 20 ms^{-1}
(4) Zero

SOLUTION

15. **Statement I :** A truck and a car moving with same kinetic energy are brought to rest by applying brakes which provide equal retarding forces. Both come to rest in equal distance.

Statement II : A car moving towards east takes a turn and moves towards north, the speed remains unchanged. The acceleration of the car is zero.

In the light of given statements, choose the most appropriate answer from the options given below.

(1) Statement I is correct but Statement II is incorrect

(2) Statement I is incorrect but Statement II is correct

(3) Both Statement I is correct but Statement II are incorrect

(4) Both Statement I is correct but Statement II are correct

16. A ball is thrown vertically upward with an initial velocity of 150 m/s. The ratio of velocity after 3 s and 5s is $\frac{x+1}{x}$. The value of x is _______.
Take ($g = 10\ m/s^2$).

(1) 6 (2) 5
(3) –5 (4) 10

17. Two trains 'A' and 'B' of length 'l' and '$4l$' are travelling into a tunnel of length 'L' in parallel tracks from opposite directions with velocities 108 km/h and 72 km/h, respectively. If train 'A' takes 35s less time than train 'B' to cross the tunnel then, length 'L' of tunnel is:(Given $L = 60\ l$)

(1) 1200 m
(2) 2700 m
(3) 1800 m
(4) 900 m

18. A passenger sitting in a train A moving at 90 km/h observes another train B moving in the opposite direction for 8 s. If the velocity of the train B is 54 km/h, then length of train B is :

(1) 80 m (2) 200 m
(3) 120 m (4) 320 m

19. The distance travelled by an object in time t is given by $s = (2\cdot5)t^2$. The instantaneous speed of the object at t = 5 s will be :

(1) 12.5 ms^{-1} (2) 62.5 ms^{-1}
(3) 5 ms^{-1} (4) 25 ms^{-1}

20. The position of a particle related to time is given by $x = (5t^2 - 4t + 5)$m. The magnitude of velocity of the particle at t = 2s will be :

(1) 10 ms^{-1} (2) 14 ms^{-1}
(3) 16 ms^{-1} (4) 06 ms^{-1}

SOLUTION

Kinematics

1. 1
2. 2
3. 4
4. 4
5. 4
6. 1
7. 3
8. 3
9. 1
10. 3
11. 3
12. 3
13. 80
14. 1
15. 1
16. 2
17. 3
18. 4
19. 4
20. 3

1. A particle moving in a circle of radius R with uniform speed takes time T to complete one revolution. If this particle is projected with the same speed at an angle θ to the horizontal, the maximum height attained by it is equal to 4R. The angle of projection θ is then given by :

(1) $\sin^{-1}\left[\frac{2gT^2}{\pi^2R}\right]^{\frac{1}{2}}$ (3) $\cos^{-1}\left[\frac{2gT^2}{\pi^2R}\right]^{\frac{1}{2}}$

(2) $\sin^{-1}\left[\frac{\pi^2R}{2gT^2}\right]^{\frac{1}{2}}$ (4) $\cos^{-1}\left[\frac{\pi R}{2gT^2}\right]^{\frac{1}{2}}$

2. A particle is moving in one dimension (along x axis) under the action of a variable force. It's initial position was 16 m right of origin. The variation of its position (x) with time (t) is given as $x = -3t^3 + 18t^2 + 16t$, where x is in m and t is in s. The velocity of the particle when its acceleration becomes zero is _________ m/s.

3. Train A is moving along two parallel rail tracks towards north with speed 72 km/h and train B is moving towards south with speed 108 km/h. Velocity of train B with respect to A and velocity of ground with respect to B are (in ms^{-1}) :

(1) –30 and 50

(2) –50 and –30

(3) –50 and 30

(4) 50 and –30

4. A particle initially at rest starts moving from reference point. x = 0 along x-axis, with velocity v that varies as $v = 4\sqrt{x}\,m/s$. The acceleration of the particle is ____ms^{-2}.

5. Position of an ant (S in metres) moving in Y-Z plane is given by $S = 2t^2\hat{j} + 5\hat{k}$ (where t is in second). The magnitude and direction of velocity of the ant at t = 1 s will be :

(1) 16 m/s in y-direction

(2) 4 m/s in x-direction

(3) 9 m/s in z-direction

(4) 4 m/s in y-direction

6. A particle starts from origin at t = 0 with a velocity $5\hat{i}\ m/s$ and moves in x-y plane under action of a force which produces a constant acceleration of $(3\hat{i} + 2\hat{j})m/s^2$. If the x-coordinate of the particle at that instant is 84 m, then the speed of the particle at this time is $\sqrt{\alpha}\ m/s$. The value of α is ______.

7. A body falling under gravity covers two points A and B separated by 80 m in 2s. The distance of upper point A from the starting point is ________ m (use $g = 10\ ms^{-2}$)

8. A body starts moving from rest with constant acceleration covers displacement S_1 in first (p – 1) seconds and S_2 in first p seconds. The displacement $S_1 + S_2$ will be made in time :

(1) $(2p+1)$s (2) $\sqrt{(2p^2-2p+1)}$s

(3) $(2p-1)$s (4) $(2p^2-2p+1)$s

9. A ball rolls off the top of a stairway with horizontal velocity u. The steps are 0.1 m high and 0.1 m wide. The minimum velocity u with which that ball just hits the step 5 of the stairway will be $\sqrt{x}\ ms^{-1}$ where x = ___________[use $g = 10\ m/s^2$].

10. A particle is moving in a straight line. The variation of position 'x' as a function of time 't' is given as $x = (t^3 - 6t^2 + 20t + 15)$ m. The velocity of the body when its acceleration becomes zero is :

(1) 4 m/s (2) 8 m/s

(3) 10 m/s (4) 6 m/s

11. The displacement and the increase in the velocity of a moving particle in the time interval of t to (t + 1) s are 125 m and 50 m/s, respectively. The distance travelled by the particle in $(t + 2)^{th}$ s is ____ m.

SOLUTION - CLICK

12. Projectiles A and B are thrown at angles of 45° and 60° with vertical respectively from top of a 400 m high tower. If their ranges and times of flight are same, the ratio of their speeds of projection $v_A : v_B$ is :

(1) $1:\sqrt{3}$ (2) $\sqrt{2}:1$

(3) $1 : 2$ (4) $1:\sqrt{2}$

13. The relation between time 't' and distance 'x' is $t = \alpha x^2 + \beta x$, where α and β are constants. The relation between acceleration (a) and velocity (v) is:

(1) $a = -2\alpha v^3$ (2) $a = -5\alpha v^5$

(3) $a = -3\alpha v^2$ (4) $a = -4\alpha v^4$

SOLUTION - CLICK

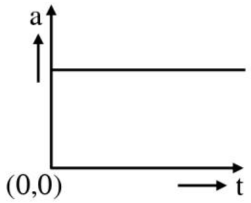
Answer Key

1. 1
2. 52
3. 3
4. 8
5. 4
6. 673
7. 45
8. 2
9. 2
10. 2
11. 175
12. Wrong Question (Still NTA Gave Option 4 as correct)
13. 1

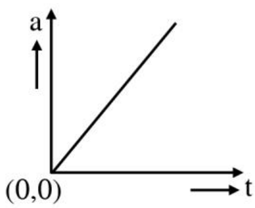
SOLUTION - CLICK

1. A wooden block, initially at rest on the ground, is pushed by a force which increases linearly with time t. Which of the following curve best describes acceleration of the block with time :

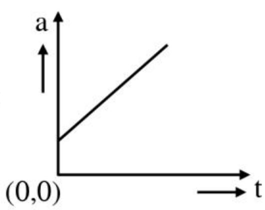
(1)



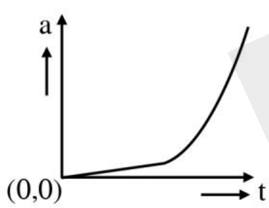
(2)



(3)



(4)



2. A body travels 102.5 m in n^{th} second and 115.0 m in $(n + 2)^{th}$ second. The acceleration is :

(1) 9 m/s^2 (3) 12.5 m/s^2

(2) 6.25 m/s^2 (4) 5 m/s^2

3. The co-ordinates of a particle moving in x-y plane are given by :

$x = 2 + 4t$, $y = 3t + 8t^2$.

The motion of the particle is :

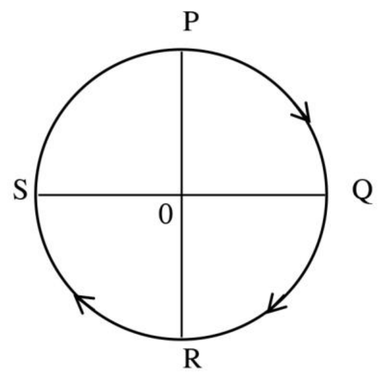
(1) non-uniformly accelerated.

(2) uniformly accelerated having motion along a straight line.

(3) uniform motion along a straight line.

(4) uniformly accelerated having motion along a parabolic path.

4. A cyclist starts from the point P of a circular ground of radius 2 km and travels along its circumference to the point S. The displacement of a cyclist is :



(1) 6 km (2) $\sqrt{8}$ km

(3) 4 km (4) 8 km

5. A bus moving along a straight highway with speed of 72 km/h is brought to halt within 4s after applying the brakes. The distance travelled by the bus during this time (Assume the retardation is uniform) is _______m.

6. A body moves on a frictionless plane starting from rest. If S_n is distance moved between $t = n - 1$ and $t = n$ and S_{n-1} is distance moved between $t = n - 2$ and $t = n - 1$, then the ratio $\frac{S_{n-1}}{S_n}$ is $\left(1 - \frac{2}{x}\right)$ for n = 10. The value of x is ....

7. The maximum height reached by a projectile is 64 m. If the initial velocity is halved, the new maximum height of the projectile is ______ m.

8. A train starting from rest first accelerates uniformly up to a speed of 80 km/h for time t, then it moves with a constant speed for time 3t. The average speed of the train for this duration of journey will be (in km/h) :

(1) 80 (2) 70

(3) 30 (4) 40

SOLUTION - CLICK

9. A body projected vertically upwards with a certain speed from the top of a tower reaches the ground in t_1. If it is projected vertically downwards from the same point with the same speed, it reaches the ground in t_2. Time required to reach the ground, if it is dropped from the top of the tower, is :

(1) $\sqrt{t_1 t_2}$ (2) $\sqrt{t_1 - t_2}$

(3) $\sqrt{\frac{t_1}{t_2}}$ (4) $\sqrt{t_1 + t_2}$

10. A particle moves in a straight line so that its displacement x at any time t is given by $x^2=1+t^2$. Its acceleration at any time t is x^{-n} where n = _____.

11. A clock has 75 cm, 60 cm long second hand and minute hand respectively. In 30 minutes duration the tip of second hand will travel x distance more than the tip of minute hand. The value of x in meter is nearly (Take $\pi = 3.14$) :

(1) 139.4 (2) 140.5

(3) 220.0 (4) 118.9

12. The angle of projection for a projectile to have same horizontal range and maximum height is :

(1) $\tan^{-1}(2)$ (2) $\tan^{-1}(4)$

(3) $\tan^{-1}\left(\frac{1}{4}\right)$ (4) $\tan^{-1}\left(\frac{1}{2}\right)$

13. A body of mass M thrown horizontally with velocity v from the top of the tower of height H touches the ground at a distance of 100m from the foot of the tower. A body of mass 2M thrown at a velocity $\frac{v}{2}$ from the top of the tower of height 4H will touch the ground at a distance of ……….m.

14. A particle moving in a straight line covers half the distance with speed 6 m/s. The other half is covered in two equal time intervals with speeds 9 m/s and 15 m/s respectively. The average speed of the particle during the motion is :

(1) 8.8 m/s (2) 10 m/s

(3) 9.2 m/s (4) 8 m/s

15. Two cars are travelling towards each other at speed of 20 m s^{-1} each. When the cars are 300 m apart, both the drivers apply brakes and the cars retard at the rate of 2 m s^{-2}. The distance between them when they come to rest is :

(1) 200 m (2) 50 m

(3) 100 m (4) 25 m

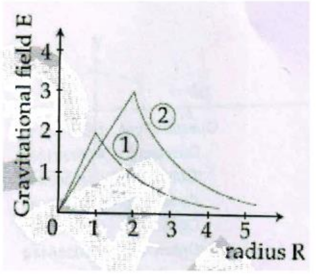
SOLUTION - CLICK

Answer Key

1. 2
2. 2
3. 4
4. 2
5. 40
6. 19
7. 16
8. 2
9. 1
10. 3
11. 1
12. 2
13. 100
14. 4
15. 3

SOLUTION - CLICK

1. Consider two solid spheres of radii $R_1 = 1\text{m}$, $R_2 = 2\text{m}$ and masses M_1 and M_2, respectively. The gravitational field due to sphere 1 and 2 are shown. The value of M_1/M_2 is



(a) 2/3 (b) 1/6
(c) 1/2 (d) 1/3

2. The value of the acceleration due to gravity is g_1 at a height $h = R/2$ (R = radius of the earth) from the surface of the earth. It is again equal to g_1 at a depth d below the surface of the earth. The ratio (d/R) equals

(a) 7/9 (b) 4/9
(c) 1/3 (d) 5/9

3. The height 'h' at which the weight of a body will be the same as that at the same depth 'h' from the surface of the earth is (Radius of the earth is R and effect of the rotation of the earth is neglected)

(a) $\dfrac{\sqrt{5}R - R}{2}$ (b) $\dfrac{\sqrt{3}}{2}R - R$
(c) $\dfrac{R}{2}$ (d) $\dfrac{\sqrt{3}R - R}{2}$

4. The mass density of a planet of radius R varies with the distance r from its centre as $\rho(r) = \rho_0\left(1 - \dfrac{r^2}{R^2}\right)$. Then the gravitational field is maximum at

(a) $r = \dfrac{1}{\sqrt{3}}R$ (b) $r = \sqrt{\dfrac{5}{9}}R$
(c) $r = \sqrt{\dfrac{3}{4}}R$ (d) $r = R$

5. A box weighs 196 N on a spring balance at the north pole. Its weight recorded on the same balance if it is shifted to the equator is close to (Take $g = 10\ \text{ms}^{-2}$ at the north pole and the radius of the earth = 6400 km)

(a) 194.66 N (b) 195.66 N
(c) 194.32 N (d) 195.32 N

6. The acceleration due to gravity on the earth's surface at poles is g and angular velocity of the earth about the axis passing through the pole is ω. An object is weighed at the equator and at a height h above the poles by using a spring balance. If the weights are found to be same, then h is ($h << R$, where R is the radius of the earth)

(a) $\dfrac{R^2\omega^2}{8g}$ (b) $\dfrac{R^2\omega^2}{4g}$
(c) $\dfrac{R^2\omega^2}{g}$ (d) $\dfrac{R^2\omega^2}{2g}$

7. Planet A has mass M and radius R. Planet B has half the mass and half the radius of Planet A. If the escape velocitites from the Planets A and B are v_A and v_B, respectively, then $\dfrac{v_A}{v_B} = \dfrac{n}{4}$. The value of n is

(a) 3 (b) 1
(c) 2 (d) 4

8. A body is moving in a low circular orbit about a planet of mass M and radius R. The radius of the orbit can be taken to be R itself. Then the ratio of the speed of this body in the orbit to the escape velocity from the planet is

(a) 1 (b) 2
(c) $\dfrac{1}{\sqrt{2}}$ (d) $\sqrt{2}$

9. A satellite is in an elliptical orbit around a planet P. It is observed that the velocity of the satellite when it is farthest from the planet is 6 times less than that when it is closest to the planet. The ratio of distances between the satellite and the planet at closest and farthest points is

(a) 1 : 6 (b) 3 : 4
(c) 1 : 3 (d) 1 : 2

10. A body A of mass m is moving in a circular orbit of radius R about a planet. Another body B of mass $m/2$ collides with A with a velocity which is half $(\vec{v}/2)$ the instantaneous velocity $\vec{v}$ of A. The collision is completely inelastic. Then, the combined body

(a) Escapes from the Planet's Gravitational field
(b) Starts moving in an elliptical orbit around the planet
(c) Falls vertically downwards towards the planet
(d) Continues to move in a circular orbit

11. A satellite of mass m is launched vertically upwards with an initial speed u from the surface of the earth. After it reaches height R (R = radius of the earth), it ejects a rocket of mass $m/10$ so that subsequently the satellite moves in a circular orbit. The kinetic energy of the rocket is (G is the gravitational constant; M is the mass of the earth)

(a) $\dfrac{3m}{8}\left(u + \sqrt{\dfrac{5GM}{6R}}\right)^2$ (b) $\dfrac{m}{20}\left(u^2 + \dfrac{113}{200}\dfrac{GM}{R}\right)$
(c) $5m\left(u^2 - \dfrac{119}{200}\dfrac{GM}{R}\right)$ (d) $\dfrac{m}{20}\left(u - \sqrt{\dfrac{2GM}{3R}}\right)^2$

12. A satellite is moving in a low nearly circular orbit around the earth. Its radius is roughly equal to that of the earth's radius R_e. By firing rockets attached to it, its speed is instantaneously increased in the direction of its motion so that it become $\sqrt{3/2}$ times larger. Due to this the farthest distance from the centre of the earth that the satellite reaches is R, value of R is

(a) $4R_e$ (b) $3R_e$
(c) $2R_e$ (d) $2.5R_e$

SOLUTION

13. The mass density of a spherical galaxy varies as $\frac{K}{r}$ over a large distance 'r' from its centre. In that region, a small star is in a circular orbit of radius R. Then the period of revolution, T depends on R as

(a) $T^2 \propto \frac{1}{R^3}$ (b) $T^2 \propto R$

(c) $T \propto R$ (d) $T^2 \propto R^3$

14. On the x-axis and a dsitance x from the origin, the gravitational field due to a mass distribution is given by $\frac{Ax}{(x^2+a^2)^{3/2}}$ in the x-direction. The magnitude of gravitational potential on the x-axis at a distance x, taking its value to be zero at infinity, is

(a) $\frac{A}{(x^2+a^2)^{1/2}}$ (b) $\frac{A}{(x^2+a^2)^{3/2}}$

(c) $A(x^2+a^2)^{3/2}$ (d) $A(x^2+a^2)^{1/2}$

15. Two planets have masses M and 16 M and their radii are a and $2a$, respectively. The separation between the centres of the planets is $10a$. A body of mass m is fired from the surface of the larger planet towards the smaller planet along the line joining their centres. For the body to be able to reach at the surface of smaller planet, the minimum firing speed needed is

(a) $\sqrt{\frac{GM^2}{ma}}$ (b) $\frac{3}{2}\sqrt{\frac{5GM}{a}}$

(c) $4\sqrt{\frac{GM}{a}}$ (d) $2\sqrt{\frac{GM}{a}}$

16. A spaceship in space sweeps stationary interplanetary dust. As a result, its mass increases at a rate $\frac{dM(t)}{dt} = bv^2(t)$, where v(t) is its instantaneous velocity. The instantaneous acceleration of the satellite is

(a) $-\frac{2b^3}{M(t)}$ (b) $-\frac{bv^3}{2M(t)}$

(c) $-bv^3(t)$ (d) $-\frac{bv^3}{M(t)}$

17. An asteroid is moving directly towards the centre of the earth. When at a distance of 10 R (R is the radius of the earth) from the earths centre, it has a speed of 12 km/s. Neglecting the effect of earths atmosphere, what will be the speed of the asteriod when it hits the surface of the earth (escape velocity from the earth is 11.2 km/s)? Give your answer to the nearest integer in kilometer/s

SOLUTION

ANSWER KEY

1. b
2. d
3. a
4. b
5. d
6. d
7. d
8. c
9. a
10. b
11. c
12. b
13. b
14. a
15. b
16. d
17. 16

Feb Attempt

1. A body weighs 49 N on a spring balance at the north pole. What will be its weight recorded on the same weighing machine, if it is shifted to the equator ?

[Use $g = \frac{GM}{R^2} = 9.8\ ms^{-2}$ and radius of earth, R = 6400 km.]

Options 1. 49.17 N 3. 48.83 N

2. 49 N 4. 49.83 N

2. Four identical particles of equal masses 1 kg made to move along the circumference of a circle of radius 1 m under the action of their own mutual gravitational attraction. The speed of each particle will be :

1. $\sqrt{G(1+2\sqrt{2})}$ 3. $\sqrt{\frac{G}{2}(1+2\sqrt{2})}$

2. $\frac{\sqrt{(1+2\sqrt{2})G}}{2}$ 4. $\sqrt{\frac{G}{2}(2\sqrt{2}-1)}$

3. Two stars of masses m and 2m at a distance d rotate about their common centre of mass in free space. The period of revolution is :

1. $\frac{1}{2\pi}\sqrt{\frac{d^3}{3Gm}}$ 3. $2\pi\sqrt{\frac{d^3}{3Gm}}$

2. $2\pi\sqrt{\frac{3Gm}{d^3}}$ 4. $\frac{1}{2\pi}\sqrt{\frac{3Gm}{d^3}}$

4. Consider two satellites S_1 and S_2 with periods of revolution 1 hr. and 8 hr. respectively revolving around a planet in circular orbits. The ratio of angular velocity of satellite S_1 to the angular velocity of satellite S_2 is :

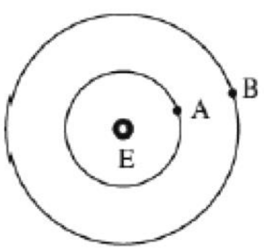
1. 2 : 1 3. 1 : 8

2. 1 : 4 4. 8 : 1

5. The initial velocity v_i required to project a body vertically upward from the surface of the earth to reach a height of 10R, where R is the radius of the earth, may be described in terms of escape velocity v_e such that $v_i = \sqrt{\frac{x}{y}} \times v_e$. The value of x will be ________ .

6. Two satellites A and B of masses 200 kg and 400 kg are revolving round the earth at height of 600 km and 1600 km respectively.
If T_A and T_B are the time periods of A and B respectively then the value of $T_B - T_A$:

[Given : radius of earth = 6400 km, mass of earth = 6×10^{24} kg]



1. 4.24×10^2 s 3. 3.33×10^2 s

2. 4.24×10^3 s 4. 1.33×10^3 s

SOLUTION

7. Assertion A : The escape velocities of planet A and B are same. But A and B are of unequal mass.

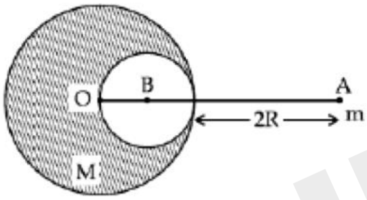
Reason R : The product of their mass and radius must be same. $M_1R_1 = M_2R_2$

In the light of the above statements, choose the most appropriate answer from the options given below :

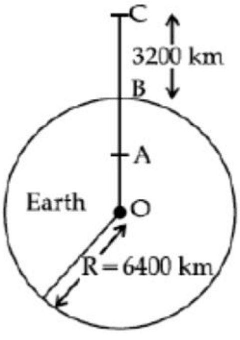
1. A is correct but R is not correct
2. Both A and R are correct and R is the correct explanation of A
3. Both A and R are correct but R is NOT the correct explanation of A
4. A is not correct but R is correct

8. A solid sphere of radius R gravitationally attracts a particle placed at 3R from its centre with a force F_1. Now a spherical cavity of radius $\left(\frac{R}{2}\right)$ is made in the sphere (as shown in figure) and the force becomes F_2. The value of $F_1 : F_2$ is :

1. 41 : 50
2. 50 : 41
3. 25 : 36
4. 36 : 25



9. In the reported figure of earth, the value of acceleration due to gravity is same at point A and C but it is smaller than that of its value at point B (surface of the earth). The value of OA : AB will be $x : y$. The value of x is ________.



10. A planet revolving in elliptical orbit has :

A. a constant velocity of revolution.

B. has the least velocity when it is nearest to the sun.

C. its areal velocity is directly proportional to its velocity.

D. areal velocity is inversely proportional to its velocity.

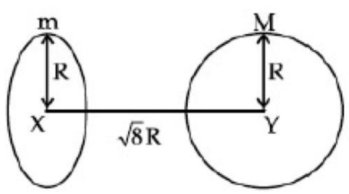
E. to follow a trajectory such that the areal velocity is constant.

Choose the correct answer from the options given below :

1. C only
2. E only
3. D only
4. A only

11. Find the gravitational force of attraction between the ring and sphere as shown in the diagram, where the plane of the ring is perpendicular to the line joining the centres. If $\sqrt{8}R$ is the distance between the centres of a ring (of mass 'm') and a sphere (mass 'M') where both have equal radius 'R'.

1. $\frac{2\sqrt{2}}{3} \cdot \frac{GMm}{R^2}$
2. $\frac{\sqrt{8}}{27} \cdot \frac{GmM}{R^2}$
3. $\frac{1}{3\sqrt{8}} \cdot \frac{GMm}{R^2}$
4. $\frac{\sqrt{8}}{9} \cdot \frac{GmM}{R}$



SOLUTION

March Attempt

1. The maximum and minimum distances of a comet from the Sun are 1.6×10^{12} m and 8.0×10^{10} m respectively. If the speed of the comet at the nearest point is 6×10^{4} ms^{-1}, the speed at the farthest point is :
(1) 1.5×10^3 m/s (2) 6.0×10^3 m/s
(3) 3.0×10^3 m/s (4) 4.5×10^3 m/s

2. If one wants to remove all the mass of the earth to infinity in order to break it up completely. The amount of energy that needs to be supplied will be $\frac{x}{5}\frac{GM^2}{R}$ where x is ____ (Round off to the Nearest Integer)
(M is the mass of earth, R is the radius of earth, G is the gravitational constant)

3. The radius in kilometer to which the present radius of earth (R = 6400 km) to be compressed so that the escape velocity is increased 10 time is _______.

4. A geostationary satellite is orbiting around an arbitary planet 'P' at a height of 11R above the surface of 'P' , R being the radius of 'P'. The time period of another satellite in hours at a height of 2R from the surface of 'P' is_________.'P' has the time period of 24 hours.
(1) $6\sqrt{2}$ (2) $\frac{6}{\sqrt{2}}$ (3) 3 (4) 5

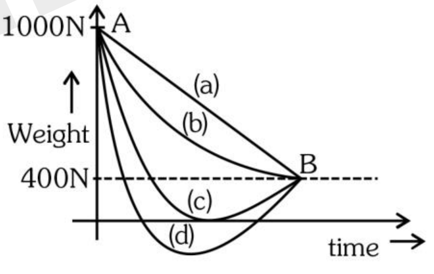
5. The time period of a satellite in a circular orbit of radius R is T. The period of another satellite in a circular orbit of radius 9R is :
(1) 9 T (2) 27 T
(3) 12 T (4) 3 T

6. If the angular velocity of earth's spin is increased such that the bodies at the equator start floating, the duration of the day would be approximately :
(Take : g = 10 ms^{-2}, the radius of earth, R = 6400×10^3 m, Take π = 3.14)
(1) 60 minutes
(2) does not change
(3) 1200 minutes
(4) 84 minutes

7. The angular momentum of a planet of mass M moving around the sun in an elliptical orbit is $\vec{L}$. The magnitude of the areal velocity of the planet is :
(1) $\frac{4L}{M}$ (2) $\frac{L}{M}$
(3) $\frac{2L}{M}$ (4) $\frac{L}{2M}$

July Attempt

1. A person whose mass is 100 kg travels from Earth to Mars in a spaceship. Neglect all other objects in sky and take acceleration due to gravity on the surface of the Earth and Mars as 10 m/s^2 and 4 m/s^2 respectively. Identify from the below figures, the curve that fits best for the weight of the passenger as a function of time.



(1) (c) (2) (a) (3) (d) (4) (b)

2. A satellite is launched into a circular orbit of radius R around earth, while a second satellite is launched into a circular orbit of radius 1.02 R. The percentage difference in the time periods of the two satellites is :
(1) 1.5 (2) 2.0
(3) 0.7 (4) 3.0

3. Consider a binary star system of star A and star B with masses m_A and m_B revolving in a circular orbit of radii r_A and r_B, respectively. If T_A and T_B are the time period of star A and star B, respectively,
then :

SOLUTION

(1) $\frac{T_A}{T_B} = \left(\frac{r_A}{r_B}\right)^{\frac{3}{2}}$

(2) $T_A = T_B$

(3) $T_A > T_B$ (if $m_A > m_B$)

(4) $T_A > T_B$ (if $r_A > r_B$)

4. A body is projected vertically upwards from the surface of earth with a velocity sufficient enough to carry it to infinity. The time taken by it to reach height h is ______ S.

(1) $\sqrt{\frac{R_e}{2g}}\left[\left(1+\frac{h}{R_e}\right)^{3/2}-1\right]$

(2) $\sqrt{\frac{2R_e}{g}}\left[\left(1+\frac{h}{R_e}\right)^{3/2}-1\right]$

(3) $\frac{1}{3}\sqrt{\frac{R_e}{2g}}\left[\left(1+\frac{h}{R_e}\right)^{3/2}-1\right]$

(4) $\frac{1}{3}\sqrt{\frac{2R_e}{g}}\left[\left(1+\frac{h}{R_e}\right)^{3/2}-1\right]$

5. The minimum and maximum distances of a planet revolving around the Sun are x_1 and x_2. If the minimum speed of the planet on its trajectory is v_0 then its maximum speed will be :

(1) $\frac{v_0 x_1^2}{x_2^2}$ (2) $\frac{v_0 x_2^2}{x_1^2}$

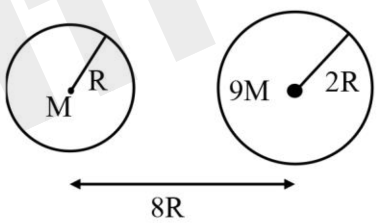
(3) $\frac{v_0 x_1}{x_2}$ (4) $\frac{v_0 x_2}{x_1}$

6. Consider a planet in some solar system which has a mass double the mass of earth and density equal to the average density of earth. If the weight of an object on earth is W, the weight of the same object on that planet will be :

(1) 2W (2) W (3) $2^{\frac{1}{3}}$ W (4) $\sqrt{2}$ W

7. Suppose two planets (spherical in shape) of radii R and 2R, but mass M and 9 M respectively have a centre to centre separation 8 R as shown in the figure. A satellite of mass 'm' is projected from the surface of the planet of mass 'M' directly towards the centre of the second planet. The minimum speed 'v' required for the satellite to reach the surface of the second planet is $\sqrt{\frac{a}{7}\frac{GM}{R}}$ then the value of 'a' is ________.

[Given : The two planets are fixed in their position]



8. Two identical particles of mass 1 kg each go round a circle of radius R, under the action of their mutual gravitational attraction. The angular speed of each particle is :

(1) $\sqrt{\frac{G}{2R^3}}$ (2) $\frac{1}{2}\sqrt{\frac{G}{R^3}}$ (3) $\frac{1}{2R}\sqrt{\frac{1}{G}}$ (4) $\sqrt{\frac{2G}{R^3}}$

9. The planet Mars has two moons, if one of them has a period 7 hours, 30 minutes and an orbital radius of 9.0×10^3 km. Find the mass of Mars.

$\left\{\text{Given } \frac{4\pi^2}{G} = 6\times10^{11}\ N^{-1}\ m^{-2}\ kg^2\right\}$

(1) 5.96×10^{19} kg (2) 3.25×10^{21} kg

(3) 7.02×10^{25} kg (4) 6.00×10^{23} kg

SOLUTION

August Attempt

1. Inside a uniform spherical shell :

(a) the gravitational field is zero

(b) the gravitational potential is zero

(c) the gravitational field is same everywhere

(d) the gravitation potential is same everywhere

(e) all of the above

Choose the most appropriate answer from the options given below :

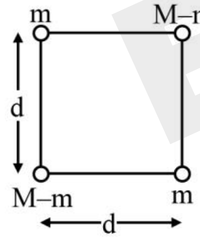
(1) (a), (c) and (d) only

(2) (e) only

(3) (a), (b) and (c) only

(4) (b), (c) and (d) only

2. A body of mass (2M) splits into four masses {m, M – m, m, M – m}, which are rearranged to form a square as shown in the figure. The ratio of $\frac{M}{m}$ for which, the gravitational potential energy of the system becomes maximum is x : 1. The value of x is ....



3. A mass of 50 kg is placed at the centre of a uniform spherical shell of mass 100 kg and radius 50 m. If the gravitational potential at a point, 25 m from the centre is V kg/m. The value of V is :

(1) – 60 G (2) + 2 G

(3) – 20 G (4) – 4 G

4. The masses and radii of the earth and moon are (M_1, R_1) and (M_2, R_2) respectively. Their centres are at a distance 'r' apart. Find the minimum escape velocity for a particle of mass 'm' to be projected from the middle of these two masses:

(1) $V=\frac{1}{2}\sqrt{\frac{4G(M_1+M_2)}{r}}$ (3) $V=\frac{1}{2}\sqrt{\frac{2G(M_1+M_2)}{r}}$

(2) $V=\sqrt{\frac{4G(M_1+M_2)}{r}}$ (4) $V=\frac{\sqrt{2G}(M_1+M_2)}{r}$

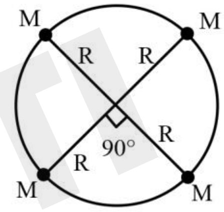
5. If R_E be the radius of Earth, then the ratio between the acceleration due to gravity at a depth 'r' below and a height 'r' above the earth surface is :

(Given : $r < R_E$)

(1) $1-\frac{r}{R_E}-\frac{r^2}{R_E^2}-\frac{r^3}{R_E^3}$ (3) $1+\frac{r}{R_E}-\frac{r^2}{R_E^2}+\frac{r^3}{R_E^3}$

(2) $1+\frac{r}{R_E}+\frac{r^2}{R_E^2}+\frac{r^3}{R_E^3}$ (4) $1+\frac{r}{R_E}-\frac{r^2}{R_E^2}-\frac{r^3}{R_E^3}$

6. Four particles each of mass M, move along a circle of radius R under the action of their mutual gravitational attraction as shown in figure. The speed of each particle is :



(1) $\frac{1}{2}\sqrt{\frac{GM}{R(2\sqrt{2}+1)}}$ (2) $\frac{1}{2}\sqrt{\frac{GM}{R}(2\sqrt{2}+1)}$

(3) $\frac{1}{2}\sqrt{\frac{GM}{R}(2\sqrt{2}-1)}$ (4) $\sqrt{\frac{GM}{R}}$

7. Two satellites revolve around a planet in coplanar circular orbits in anticlockwise direction. Their period of revolutions are 1 hour and 8 hours respectively. The radius of the orbit of nearer satellite is 2×10^3 km. The angular speed of the farther satellite as observed from the nearer satellite at the instant when both the satellites are closest is $\frac{\pi}{x}$ rad h^{-1} where x is ....

SOLUTION

ANSWER KEY

Feb Attempt

1. 3
2. 2
3. 3
4. 4
5. 10
6. 4
7. 1
8. 2
9. 4
10.2
11. 2

March Attempt

1. 3
2. 3
3. 64
4. 3
5. 2
6. 4
7. 4

July Attempt

1. 1
2. 4
3. 2
4. 4
5. 4
6. 3
7. 4
8. 2
9. 4

August Attempt

1. 1
2. 2
3. 4
4. 2
5. 4
6. 2
7. 3

1. The approximate height from the surface of earth at which the weight of the body becomes $\frac{1}{3}$ of its weight on the surface of earth is : [Radius of earth $R = 6400$ km and $\sqrt{3} = 1.732$]

(A) 3840 km (B) 4685 km

(C) 2133 km (D) 4267 km

2. The distance between Sun and Earth is R. The duration of year if the distance between Sun and Earth becomes 3R will be :

(A) $\sqrt{3}$ years (B) 3 years

(C) 9 years (D) $3\sqrt{3}$ years

3. The height of any point P above the surface of earth is equal to diameter of earth. The value of acceleration due to gravity at point P will be : (Given g = acceleration due to gravity at the surface of earth)

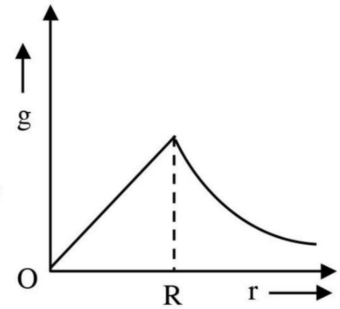
(A) g/2 (B) g/4

(C) g/3 (D) g/9

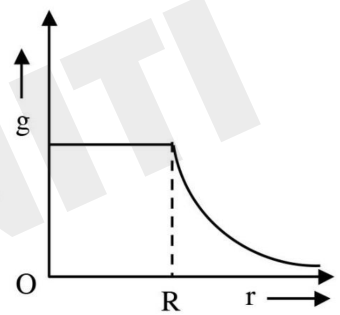
4. Two satellites S_1 and S_2 are revolving in circular orbits around a planet with radius $R_1 = 3200$ km and $R_2 = 800$ km respectively. The ratio of speed of satellite S_1 to the speed of satellite S_2 in their respective orbits would be $\frac{1}{x}$ where x =

5. The variation of acceleration due to gravity (g) with distance (r) from the center of the earth is correctly represented by : (Given R = radius of earth)

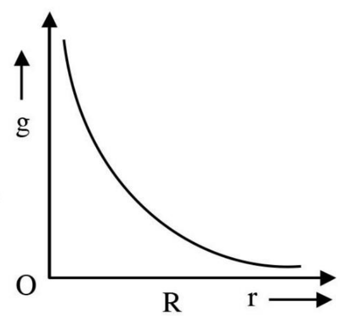
(A)



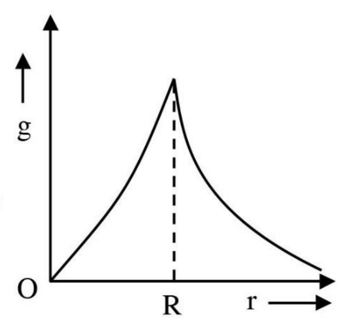
(B)



(C)



(D)



SOLUTION

6. Given below are two statements : One is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : If we move from poles to equator, the direction of acceleration due to gravity of earth always points towards the center of earth without any variation in its magnitude.

Reason R : At equator, the direction of acceleration due to the gravity is towards the center of earth.

In the light of above statements, choose the correct answer from the options given below :

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is NOT the correct explanation of A.

(C) A is true but R is false

(D) A is false but R is true

7. **Statement I :** The law of gravitation holds good for any pair of bodies in the universe.

Statement II : The weight of any person becomes zero when the person is at the centre of the earth.

In the light of the above statements, choose the correct answer from the options given below.

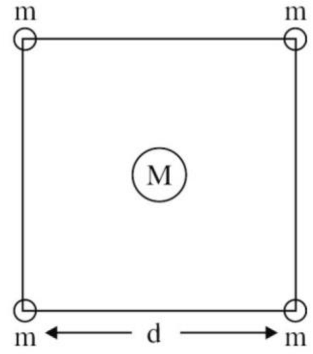
(A) Both statement I and Statement II are true

(B) Both statement I and Statement II are false

(C) Statement I is true but Statement II are false

(D) Statement I is false but Statement II is true

8. Four spheres each of mass m form a square of side d (as shown in figure). A fifth sphere of mass M is situated at the centre of square. The total gravitational potential energy of the system is :



(A) $-\frac{Gm}{d}\left[(4+\sqrt{2})m+4\sqrt{2}M\right]$

(B) $-\frac{Gm}{d}\left[(4+\sqrt{2})M+4\sqrt{2}m\right]$

(C) $-\frac{Gm}{d}\left[3m^2+4\sqrt{2}M\right]$

(D) $-\frac{Gm}{d}\left[6m^2+4\sqrt{2}M\right]$

9. Two planets A and B of equal mass are having their period of revolutions T_A and T_B such that $T_A = 2T_B$. These planets are revolving in the circular orbits of radii r_A and r_B respectively. Which out of the following would be the correct relationship of their orbits?

(A) $2r_A^2 = r_B^2$

(B) $r_A^3 = 2r_B^3$

(C) $r_A^3 = 4r_B^3$

(D) $T_A^2 - T_B^2 = \frac{\pi^2}{GM}\left(r_B^3 - 4r_A^3\right)$

SOLUTION

10. Two objects of equal masses placed at certain distance from each other attracts each other with a force of F. If one-third mass of one object is transferred to the other object, then the new force will be :

(A) $\frac{2}{9}F$ (B) $\frac{16}{9}F$

(C) $\frac{8}{9}F$ (D) F

11. The escape velocity of a body on a planet 'A' is 12 kms^{-1}. The escape velocity of the body on another planet 'B', whose density is four times and radius is half of the planet 'A', is :

(A) 12 kms^{-1} (B) 24 kms^{-1}

(C) 36 kms^{-1} (D) 6 kms^{-1}

12. The time period of a satellite revolving around earth in a given orbit is 7 hours. If the radius of orbit is increased to three times its previous value, then approximate new time period of the satellite will be :

(A) 40 hours (B) 36 hours

(C) 30 hours (D) 25 hours

SOLUTION

Gravitation

1. B
2. D
3. D
4. 2
5. A
6. D
7. A
8. A
9. C
10. C
11. A
12. B

1. Three identical particle A, B and C of mass 100 kg each are placed in a straight line with AB = BC = 13 m. The gravitational force on a fourth particle P of the same mass is F, when placed at a distance 13 m from the particle B on the perpendicular bisector of the line AC. The value of F will be approximately :

(A) 21 G (B) 100 G

(C) 59 G (D) 42 G

2. An object is taken to a height above the surface of earth at a distance $\frac{5}{4}R$ from the centre of the earth. Where radius of earth, R = 6400 km. The percentage decrease in the weight of the object will be

(A) 36% (B) 50%

(C) 64% (D) 25%

3. The percentage decrease in the weight of a rocket, when taken to a height of 32 km above the surface of earth will, be :

(Radius of earth = 6400km)

(A) 1 % (B) 3%

(C) 4% (D) 0.5%

4. A body is projected vertically upwards from the surface of earth with a velocity equal to one third of escape velocity. The maximum height attained by the body will be:

(Take radius of earth = 6400 km and g=10 ms^{-2})

(A) 800 km (B) 1600 km

(C) 2133 km (D) 4800 km

5. Two satellites A and B having masses in the ratio 4 : 3 are revolving in circular orbits of radii 3r and 4 r respectively around the earth. The ratio of total mechanical energy of A to B is :

(A) 9 : 16 (B) 16 : 9

(C) 1 : 1 (D) 4 : 3

SOLUTION

6. A body of mass m is projected with velocity λv_e in vertically upward direction from the surface of the earth into space. It is given that v_e is escape velocity and $\lambda < 1$. If air resistance is considered to the negligible, then the maximum height from the centre of earth, to which the body can go, will be (R : radius of earth)

(A) $\frac{R}{1+\lambda^2}$ (B) $\frac{R}{1-\lambda^2}$ (C) $\frac{R}{1-\lambda}$ (D) $\frac{\lambda^2 R}{1-\lambda^2}$

7. If the radius of earth shrinks by 2% while its mass remains same. The acceleration due to gravity on the earth's surface will approximately :

(A) decrease by 2% (B) decrease by 4%

(C) increase by 2% (D) increase by 4%

8. Assume there are two identical simple pendulum Clocks-1 is placed on the earth and Clock-2 is placed on a space station located at a height h above the earth surface. Clock-1 and Clock-2 operate at time periods 4s and 6s respectively. Then the value of h is –

(consider radius of earth R_E = 6400 km and g on earth 10 m/s^2)

(A) 1200 km (B) 1600 km

(C) 3200 km (D) 4800 km

9. If the acceleration due to gravity experienced by a point mass at a height h above the surface of earth is same as that of the acceleration due to gravity at a depth αh ($h << R_e$) from the earth surface. The value of α will be _________.

(use R_e = 6400 km)

10. An object of mass 1 kg is taken to a height from the surface of earth which is equal to three times the radius of earth. The gain in potential energy of the object will be

[If, g=10ms^{-2} and radius of earth = 6400 km]

(A) 48 MJ (B) 24 MJ

(C) 36 MJ (D) 12 MJ

ANSWER KEY

1. B
2. A
3. A
4. A
5. B
6. B
7. D
8. C
9. 2
10. A

1. **Statement-I**: Acceleration due to gravity is different at different places on the surface of earth.
Statement-II: Acceleration due to gravity increases as we go down below the earth's surface.
In the light of the above statements, choose the **correct** answer from the options given below
(1) Both Statement I and Statement II are true
(2) Both Statement I and Statement II are false
(3) Statement I is true but Statement II is false
(4) Statement I is false but Statement II is true

2. If earth has a mass nine times and radius twice to the of a planet P. Then $\frac{v_e}{3}\sqrt{x}\ \text{ms}^{-1}$ will be the minimum velocity required by a rocket to pull out of gravitational force of P, where v_e is escape velocity on earth. The value of x is
(1) 2 (2) 3
(3) 18 (4) 1

3. The escape velocities of two planets A and B are in the ratio 1 : 2. If the ratio of their radii respectively is 1 : 3, then the ratio of acceleration due to gravity of planet A to the acceleration of gravity of planet B will be:
(1) $\frac{4}{3}$ (2) $\frac{3}{2}$
(3) $\frac{2}{3}$ (4) $\frac{3}{4}$

4. The weight of a body at the surface of earth is 18 N. The weight of the body at an altitude of 3200 km above the earth's surface is (given, radius of earth R_e = 6400 km)
(1) 9.8 N (2) 4.9 N
(3) 19.6 N (4) 8 N

5. If the distance of the earth from Sun is 1.5×10^6 km. Then the distance of an imaginary planet from Sun, if its period of revolution is 2.83 years is:
(1) 6×10^7 km
(2) 6×10^6 km
(3) 3×10^6 km
(4) 3×10^7 km

6. Given below are two statements:
Statement I: Acceleration due to earth's gravity decreases as you go 'up' or 'down' from earth's surface.
Statement II: Acceleration due to earth's gravity is same at a height 'h' and depth 'd' from earth's surface, if h = d.
In the light of above statements, choose the ***most appropriate*** answer form the options given below
(1) Statement I is incorrect but statement II is correct
(2) Both Statement I and Statement II are incorrect
(3) Statement I is correct but statement II is incorrect
(4) Both Statement I and II are correct

7. A body of mass is taken from earth surface to the height h equal to twice the radius of earth (R_e), the increase in potential energy will be : (g = acceleration due to gravity on the surface of Earth)
(1) $3mgR_e$ (2) $\frac{1}{3}mgR_e$
(3) $\frac{2}{3}mgR_e$ (4) $\frac{1}{2}mgR_e$

8. Every planet revolves around the sun in an elliptical orbit :
A. The force acting on a planet is inversely proportional to square of distance from sun.
B. Force acting on planet is inversely proportional to product of the masses of the planet and the sun
C. The centripetal force acting on the planet is directed away from the sun.
D. The square of time period of revolution of planet around sun is directly proportional to cube of semi-major axis of elliptical orbit.
Choose the correct answer from the options given below :
Options :
(1) A and D only (2) C and D only
(3) B and C only (4) A and C only

SOLUTION

9. Two particles of equal mass 'm' move in a circle of radius 'r' under the action of their mutual gravitational attraction. The speed of each particle will be :

(1) $\sqrt{\frac{GM}{2r}}$ (2) $\sqrt{\frac{4GM}{r}}$

(3) $\sqrt{\frac{GM}{r}}$ (4) $\sqrt{\frac{GM}{4r}}$

10. The time period of a satellite of earth is 24 hours. If the separation between the earth and the satellite is decreased to one fourth of the previous value, then its new time period will become.

(1) 4 hours (2) 6 hours

(3) 12 hours (4) 3 hours

11. If the gravitational field in the space is given as $\left(-\frac{K}{r^2}\right)$. Taking the reference point to be at r = 2 cm with gravitational potential V = 10 J/kg. Find the gravitational potential at r = 3 cm in SI unit (Given, that K = 6 J cm/kg)

(1) 9 (2) 11

(3) 12 (4) 10

12. An object is allowed to fall from a height R above the earth, where R is the radius of earth. Its velocity when it strikes the earth's surface, ignoring air resistance, will be :

(1) $2\sqrt{gR}$ (2) $\sqrt{gR}$

(3) $\sqrt{\frac{gR}{2}}$ (4) $\sqrt{2gR}$

13. At a certain depth "d" below surface of earth. value of acceleration due to gravity becomes four times that of its value at a height 3R above earth surface. Where R is Radius of earth (Take R = 6400 km). The depth d is equal to

(1) 5260 km (2) 640 km

(3) 2560 km (4) 4800 km

14. A body weight W, is projected vertically upwards from earth's surface to reach a height above the earth which is equal to nine times the radius of earth. The weight of the body at that height will be:

(1) $\frac{W}{91}$ (2) $\frac{W}{100}$

(3) $\frac{W}{9}$ (4) $\frac{W}{3}$

SOLUTION

GRAVITATION

1. 3
2. 1
3. 4
4. 4
5. 3
6. 3
7. 3
8. 1
9. 4
10. 4
11. 2
12. 2
13. 4
14. 2

1. A planet has double the mass of the earth. Its average density is equal to the that of the earth. An object weighing W on earth will weigh on that planet :
(1) $2^{2/3}$ W
(2) W
(3) $2^{1/3}$ W
(4) 2 W

2. **Assertion A** and the other is labelled as **Reason R.**
Assertion A : Earth has atmosphere whereas moon doesn't have any atmosphere.
Reason R : The escape velocity on moon is very small as compared to that on earth.
In the light of the above statement, choose the correct answer from the options given below :
(1) A is true but R is false
(2) A is false but R is true
(3) Both A and R are correct but R is NOT the correct explanation of A
(4) Both A and R are correct and R is correct explanation of A

3. Choose the incorrect statement from the following:
(1) The speed of satellite in a given circular orbit remains constant.
(2) For a planet revolving around the sun in an elliptical orbit, the total energy of the planet remains constant.
(3) When a body fall towards earth, the displacement of earth towards the body is negligible.
(4) The linear speed of a planet revolving around the sun remains constant.

4. The weight of a body on the surface of the earth is 100 N. The gravitational force on it when taken at a height, from the surface of earth, equal to one-fourth the radius of the earth is:
(1) 100 N (2) 64 N
(3) 50 N (4) 25 N

5. The weight of a body on the earth is 400 N. Then weight of the body when taken to a depth half of the radius of the earth will be:
(1) Zero (2) 300 N
(3) 100 N (4) 200 N

6. **Statement I :**
If E be the total energy of a satellite moving around the earth, then its potential energy will be $\frac{E}{2}$.
Statement II:
The kinetic energy of a satellite revolving in an orbit is equal to the half the magnitude of total energy E.
In the light of the above statements, choose the most appropriate answer from the options given below
(1) Both Statement I and Statement II are correct
(2) Both Statement I and Statement II are incorrect
(3) Statement I is incorrect but Statement II is correct
(4) Statement I is correct but Statement II is incorrect

7. The orbital angular momentum of a satellite is L, when it is revolving in a circular orbit at height h from earth surface. If the distance of satellite from the earth centre is increased by eight times to its initial value, then the new angular momentum will be-
(1) 8 L (2) 4 L
(3) 9 L (4) 3 L

8. The acceleration due to gravity at height h above the earth if h <<R (radius of earth) is given by
(1) $g' = g\left(1 - \frac{2h}{R}\right)$ (2) $g' = g\left(1 - \frac{2h^2}{R^2}\right)$
(3) $g' = g\left(1 - \frac{h}{2R}\right)$ (4) $g' = g\left(1 - \frac{h^2}{2R^2}\right)$

SOLUTION

9. Assuming the earth to be a sphere of uniform mass density, the weight of a body at a depth $d = \frac{R}{2}$ from the surface of earth, if its weight on the surface of earth is 200 N, will be:
(Given R = Radius of earth)
(1) 400 N (2) 500 N
(3) 300 N (4) 100 N

10. Two satellites of masses m and 3m revolve around the earth in circular orbits of radii r & 3r respectively. The ratio of orbital speeds of the satellites respectively is :
(1) 1 : 1 (2) 3 : 1
(3) $\sqrt{3}:1$ (4) 9 : 1

11. **Statement I:** Rotation of the earth shows effect on the value of acceleration due to gravity (g).
Statement II: The effect of rotation of the earth on the value of 'g' at the equator is minimum and that at the pole is maximum.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is false but Statement II is true.
(2) Statement I is true but Statement II are false.
(3) Both Statement I and Statement II are true.
(4) Both Statement I and Statement II are false.

12. The time period of a satellite, revolving above earth's surface at a height equal to R will be
(Given $g = \pi^2$ m/s^2, R = radius of earth)
(1) $\sqrt{4R}$
(2) $\sqrt{8R}$
(3) $\sqrt{32R}$
(4) $\sqrt{2R}$

13. The radii of two planets 'A' and 'B' are 'R' and '4R' and their densities are ρ and $\rho/3$ respectively. The ratio of acceleration due to gravity at their surfaces ($g_A : g_B$) will be :
(1) 1 : 16 (2) 3 : 16
(3) 3 : 4 (4) 4 : 3

14. If V is the gravitational potential due to sphere of uniform density on it's surface, then it's value at the center of sphere will be:-
(1) $\frac{3V}{2}$ (2) V
(3) $\frac{4}{3}V$ (4) $\frac{V}{2}$

15. A spaceship of mass 2×10^4 kg is launched into a circular orbit close to the earth surface. The additional velocity to be imparted to the spaceship in the orbit to overcome the gravitational pull will be (if g = 10 m/s^2 and radius of earth = 6400 km)
(1) $11.2\left(\sqrt{2}-1\right)$ km/s
(2) $7.9\left(\sqrt{2}-1\right)$ km/s
(3) $8\left(\sqrt{2}-1\right)$ km/s
(4) $7.4\left(\sqrt{2}-1\right)$ km/s

16. Two satellites A and B move round the earth in the same orbit. The mass of A is twice the mass of B. The quantity which is same for the two satellites will be :
(1) Potential energy (2) Total energy
(3) Kinetic energy (4) Speed

17. The ratio of escape velocity of a planet to the escape velocity of earth will be:
Given : Mass of the planet is 16 times mass of earth and radius of the planet is 4 times the radius of earth.
(1) 4 : 1 (2) 2 : 1
(3) $1:\sqrt{2}$ (4) 1 : 4

SOLUTION

18. A planet having mass 9 Me and radius $4R_e$, where Me and Re are mass and radius of earth respectively, has escape velocity in km/s given by: (Given escape velocity on earth $V_e = 11.2 \times 10^3$ m/s)
(1) 67.2
(2) 16.8
(3) 33.6
(4) 11.2

19. **Statement I:** For a planet, if the ratio of mass of the planet to its radius increases, the escape velocity from the planet also increases.
Statement II: Escape velocity is independent of the radius of the planet.
In the light of above statements, choose the ***most appropriate*** answer from the options given below
(1) Both Statement I and Statement II are incorrect
(2) Statement I is correct but statement II is incorrect
(3) Statement I is incorrect but statement II is correct
(4) Both Statement I and Statement II are correct

20. Two planets A and B of radii R and 1.5 R have densities ρ and ρ/2 respectively. The ratio of acceleration due to gravity at the surface of B to A is :
(1) 2 : 3 (2) 2 : 1
(3) 3 : 4 (4) 4 : 3

21. Two identical particles each of mass 'm' go round a circle of radius *a* under the action of their mutual gravitational attraction. The angular speed of each particle will be :
(1) $\sqrt{\frac{Gm}{2a^3}}$ (2) $\sqrt{\frac{Gm}{8a^3}}$
(3) $\sqrt{\frac{Gm}{4a^3}}$ (4) $\sqrt{\frac{Gm}{a^3}}$

22. A body is released from a height equal to the radius (R) of the earth. The velocity of the body when it strikes the surface of the earth will be :
(Given g = acceleration due to gravity on the earth.)
(1) $\sqrt{gR}$ (2) $\sqrt{4gR}$
(3) $\sqrt{2gR}$ (4) $\sqrt{\frac{gR}{2}}$

SOLUTION

Gravitation

1. 3
2. 4
3. 4
4. 2
5. 4
6. 2
7. 4
8. 1
9. 4
10. 3
11. 2
12. 3
13. 3
14. 1
15. 3
16. 4
17. 2
18. 2
19. 2
20. 3
21. 3
22. 1

1. A light planet is revolving around a massive star in a circular orbit of radius R with a period of revolution T. If the force of attraction between planet and star is proportional to $R^{-3/2}$ then choose the correct option :
(1) $T^2 \propto R^{5/2}$ (2) $T^2 \propto R^{7/2}$
(3) $T^2 \propto R^{3/2}$ (4) $T^2 \propto R^3$

2. The acceleration due to gravity on the surface of earth is g. If the diameter of earth reduces to half of its original value and mass remains constant, then acceleration due to gravity on the surface of earth would be :
(1) g/4 (2) 2g
(3) g/2 (4) 4g

3. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The angular speed of the moon in its orbit about the earth is more than the angular speed of the earth in its orbit about the sun.
Reason (R) : The moon takes less time to move around the earth than the time taken by the earth to move around the sun.
In the light of the above statements, choose the most appropriate answer from the options given below :
(1) (A) is correct but (R) is not correct
(2) Both (A) and (R) are correct and (R) is the correct explanation of (A)
(3) Both (A) and (R) are correct but (R) is not the correct explanation of (A)
(4) (A) is not correct but (R) is correct

4. At what distance above and below the surface of the earth a body will have same weight, (take radius of earth as R.)
(1) $\sqrt{5}R - R$ (2) $\frac{\sqrt{3}R - R}{2}$
(3) $\frac{R}{2}$ (4) $\frac{\sqrt{5}R - R}{2}$

SOLUTION - CLICK

5. A planet takes 200 days to complete one revolution around the Sun. If the distance of the planet from Sun is reduced to one fourth of the original distance, how many days will it take to complete one revolution ?
(1) 25 (2) 50
(3) 100 (4) 20

6. The gravitational potential at a point above the surface of earth is $-5.12\times10^7\ J/kg$ and the acceleration due to gravity at that point is 6.4 m/s^2. Assume that the mean radius of earth to be 6400 km. The height of this point above the earth's surface is :
(1) 1600 km
(2) 540 km
(3) 1200 km
(4) 1000 km

7. Escape velocity of a body from earth is 11.2 km/s. If the radius of a planet be one-third the radius of earth and mass be one-sixth that of earth, the escape velocity from the plate is:
(1) 11.2 km/s
(2) 8.4 km/s
(3) 4.2 km/s
(4) 7.9 km/s

8. Four identical particles of mass m are kept at the four corners of a square. If the gravitational force exerted on one of the masses by the other masses is $\left(\frac{2\sqrt{2}+1}{32}\right)\frac{Gm^2}{L^2}$, the length of the sides of the square is
(1) $\frac{L}{2}$ (2) 4L
(3) 3L (4) 2L

9. The mass of the moon is 1/144 times the mass of a planet and its diameter 1/16 times the diameter of a planet. If the escape velocity on the planet is v, the escape velocity on the moon will be:
(1) $\frac{v}{3}$ (2) $\frac{v}{4}$ (3) $\frac{v}{12}$ (4) $\frac{v}{6}$

Answer Key

1. 1
2. 4
3. 2
4. 4
5. 1
6. 1
7. 4
8. 2
9. 1

SOLUTION - CLICK

1. A metal wire of uniform mass density having length L and mass M is bent to form a semicircular arc and a particle of mass m is placed at the centre of the arc. The gravitational force on the particle by the wire is:

(1) $\frac{GMm\pi}{2L^2}$

(2) 0

(3) $\frac{GmM\pi^2}{L^2}$

(4) $\frac{2GmM\pi}{L^2}$

2. Correct formula for height of a satellite from earths surface is :

(1) $\left(\frac{T^2R^2g}{4\pi}\right)^{1/2} - R$

(2) $\left(\frac{T^2R^2g}{4\pi^2}\right)^{1/3} - R$

(3) $\left(\frac{T^2R^2}{4\pi^2 g}\right)^{1/3} - R$

(4) $\left(\frac{T^2R^2}{4\pi^2}\right)^{-1/3} + R$

3. A 90 kg body placed at 2R distance from surface of earth experiences gravitational pull of :
(R = Radius of earth, g = 10 ms^{-2})

(1) 300 N (2) 225 N

(3) 120 N (4) 100 N

4.

	List-I		List-II
(A)	Kinetic energy of planet	(I)	$-\frac{GMm}{a}$
(B)	Gravitation Potential energy of Sun-planet system.	(II)	$\frac{GMm}{2a}$
(C)	Total mechanical energy of planet	(III)	$\frac{Gm}{r}$
(D)	Escape energy at the surface of planet for unit mass object	(IV)	$-\frac{GMm}{2a}$

(Where a = radius of planet orbit, r = radius of planet, M = mass of Sun, m = mass of planet)
Choose the correct answer from the options given below:

(1) (A) – II, (B) – I, (C) – IV, (D) – III

(2) (A) – III, (B) – IV, (C) – I, (D) – II

(3) (A) – I, (B) – IV, (C) – II, (D) – III

(4) (A) – I, (B) – II, (C) – III, (D) – IV

5. A satellite revolving around a planet in stationary orbit has time period 6 hours. The mass of planet is one-fourth the mass of earth. The radius orbit of planet is : (Given = Radius of geo-stationary orbit for earth is 4.2×10^4 km)

(1) 1.4×10^4 km (2) 8.4×10^4 km

(3) 1.68×10^5 km (4) 1.05×10^4 km

6. To project a body of mass m from earth's surface to infinity, the required kinetic energy is (assume, the radius of earth is R_E, g = acceleration due to gravity on the surface of earth) :

(1) $2mgR_E$ (2) mgR_E

(3) $\frac{1}{2}mgR_E$ (4) $4mgR_E$

7. Assuming the earth to be a sphere of uniform mass density, a body weighed 300 N on the surface of earth. How much it would weigh at R/4 depth under surface of earth ?

(1) 75 N (2) 375 N

(3) 300 N (4) 225 N

SOLUTION - CLICK

8. Two planets A and B having masses m_1 and m_2 move around the sun in circular orbits of r_1 and r_2 radii respectively. If angular momentum of A is L and that of B is 3L, the ratio of time period $\left(\frac{T_A}{T_B}\right)$ is:

(1) $\left(\frac{r_2}{r_1}\right)^{\frac{3}{2}}$ (2) $\left(\frac{r_1}{r_2}\right)^3$

(3) $\frac{1}{27}\left(\frac{m_2}{m_1}\right)^3$ (4) $27\left(\frac{m_1}{m_2}\right)^3$

9. Two satellite A and B go round a planet in circular orbits having radii 4 R and R respectively. If the speed of A is $3v$, the speed of B will be :

(1) $\frac{4}{3}v$ (2) $3v$

(3) $6v$ (4) $12v$

10. An astronaut takes a ball of mass m from earth to space. He throws the ball into a circular orbit about earth at an altitude of 318.5 km. From earth's surface to the orbit, the change in total mechanical energy of the ball is $x\frac{GM_e m}{21R_e}$. The value of x is (take $R_e = 6370$ km):

(1) 11 (2) 9

(3) 12 (4) 10

11. A satellite of 10^3 kg mass is revolving in circular orbit of radius 2R. If $\frac{10^4 R}{6} J$ energy is supplied to the satellite, it would revolve in a new circular orbit of radius :

(use $g = 10 m/s^2$, R = radius of earth)

(1) 2.5 R (2) 3 R

(3) 4 R (4) 6 R

SOLUTION - CLICK

Answer Key

1. 4
2. 2
3. 4
4. 1
5. 4
6. 2
7. 4
8. 3
9. 3
10. 1
11. 4

SOLUTION - CLICK

1. Consider two ideal diatomic gases A and B at some temperature T. Molecules of the gas A are rigid, and have a mass m. Molecules of the gas B have an additional vibrational mode, and have a mass $m/4$. The ratio of the specific heats (C_V^A and C_V^B) of gas A and B, respectively is

(a) 5 : 9 (b) 7 : 9
(c) 3 : 5 (d) 5 : 7

2. Consider a mixture of n moles of heilum gas and $2n$ moles of oxygen gas (molecules taken to be rigid) as an ideal gas. Its C_p/C_v value will be

(a) 40/27 (b) 23/15
(c) 19/13 (d) 67/45

3. Two moles of an ideal gas with $\frac{C_P}{C_V}=\frac{5}{3}$ are mixed with 3 moles of another ideal gas with $\frac{C_P}{C_V}=\frac{4}{3}$. The value of $\frac{C_P}{C_V}$ for the mixture is

(a) 1.50 (b) 1.45
(c) 1.47 (d) 1.42

4. A gas mixture consists of 3 moles of oxygen and 5 moles of argon at temperature T. Assuming the gases to be ideal and the oxygen bond to be rigid, the total internal energy (in units of RT) of the mixture is

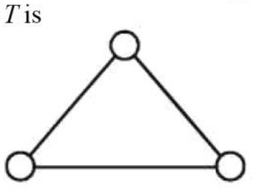
(a) 13 (b) 15
(c) 20 (d) 11

5. Match the C_p/C_V ratio for ideal gases with different type of molecules

Molecular type	C_p/C_V
(A) Monoatomic	(I) 7/5
(B) Diatomic rigid molecules	(II) 9/7
(C) Diatomic non-rigid molecules	(III) 4/3
(D) Triatomic rigid molecules	(IV) 5/3

(a) A-IV, B-I, C-II, D-III (b) A-IV, B-II, C-I, D-III
(c) A-III, B-IV, C-II, D-I (d) A-II, B-III, C-I, D-IV

6. Consider a gas of triatomic molecules. The molecules are assumed to the triangular and made of massless rigid rods whose vertices are occupied by atoms. The internal energy of a mole of the gas at temperature T is



(a) $\frac{9}{2}RT$
(b) $\frac{3}{2}RT$
(c) $\frac{5}{2}RT$ (d) $3RT$

7. To raise the temperature of a certain mass of gas by 50°C at a constant pressure, 160 calories of heat is required. When the same mass of gas is cooled by 100°C at constant volume, 240 calories of heat is released. How many degrees of freedom does each molecule of this gas have (assume gas to be ideal)?

(a) 5 (b) 3
(c) 6 (d) 7

8. Molecules of an ideal gas are known to have three translational degrees of freedom and two rotational degrees of freedom. The gas is maintained at a temperature of T. The total internal energy, U of a mole of this gas, and the value of $\gamma\left(=\frac{C_P}{C_v}\right)$ are given, respectively, by

(a) $U=\frac{5}{2}RT$ and $\gamma=\frac{6}{5}$ (b) $U=5RT$ and $\gamma=\frac{7}{5}$

(c) $U=5RT$ and $\gamma=\frac{6}{5}$ (d) $U=\frac{5}{2}RT$ and $\gamma=\frac{7}{5}$

9. Number of molecules in a volume of 4 cm³ of a perfect monatomic gas at some temperature T and at a pressure of 2 cm of mercury is close to? (Given, mean kinetic energy of a molecule (at T) is 4×10^{-14} erg, g = 980 cm/s², density of mercury = 13.6 g/cm³)

(a) 5.8×10^{18} (b) 5.8×10^{16}
(c) 4.0×10^{18} (d) 4.0×10^{16}

10. An ideal gas in a closed container is slowly heated. As its temperature increases, which of the following statements are true?

(a) the mean free path of the molecules decreases.
(b) the mean collision time between the molecules decreases.
(c) the mean free path remains unchanged.
(d) the mean collision time remains unchanged.

(a) (C) and (D) (c) (A) and (B)
(c) (A) and (D) (d) (B) and (C)

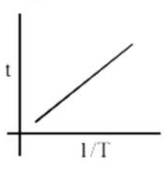
11. In a dilute gas at pressure P and temperature T, the mean time between successive collisions of a molecule varies with T as

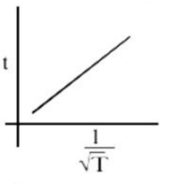
(a) $\sqrt{T}$ (b) $1/T$
(c) $1/\sqrt{T}$ (d) T

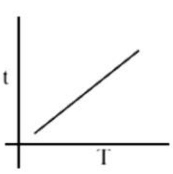
12. Two gases-argon (atomic radius 0.07 nm, atomic weight 40) and xenon (atomic radius 0.1 nm, atomic weight 140) have the same number density and are at the same temperature. The ratio of their respective mean free times is closest to

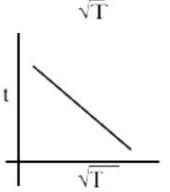
(a) 1.09 (b) 2.3
(c) 1.83 (d) 3.67

13. The plot that depicts the behavior of the mean free time τ (time between two successive collisions) for the molecules of an ideal gas, as a function of temperature (T), qualitatively, is (Graphs are schematic and not drawn to scale)

(a)


(b)


(c)


(d)


SOLUTION

14. Under an adiabatic process, the volume of an ideal gas gets doubled. Consequently the mean collision time between the gas molecule changes from τ_1 to τ_2. If $C_p/C_v=\gamma$ for this gas, then a good estimate for τ_2/τ_1 is given by

(a) $\left(\frac{1}{2}\right)^{\frac{\gamma+1}{2}}$ (b) $\frac{1}{2}$

(c) $2^{\frac{\gamma+1}{2}}$ (d) 2

15. A balloon filled with helium (32°C and 1.7 atm.) bursts. Immediately afterwards the expansion of helium can be considered as

(a) Irreversible isothermal (b) Irreversible adiabatic
(c) Reversible adiabatic (d) Reversible isothermal

16. A litre of dry air at STP expands adiabatically to a volume of 3 litres. If $\gamma = 1.40$, the work done by air is $(3^{1.4} = 4.6555)$ [Take air to be an ideal gas]

(a) 60.7 J (b) 100.8 J
(c) 90.5 J (d) 48 J

17. In an adiabatic process, the density of a diatomic gas becomes 32 times its initial value. The final pressure of the gas is found to be n times the initial pressure. The value of n is

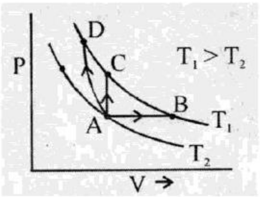
(a) 326 (b) 1/32
(c) 32 (d) 128

18. Match the thermodynamic processes taking place in a system with the correct conditions. In the table : ΔQ is the heat supplied, ΔW is the work done and ΔU is change in internal energy of the system

Process	**Condition**
(I) Adiabatic	(A) $\Delta W = 0$
(II) Isothermal	(B) $\Delta Q = 0$
(III) Isochoric	(C) $\Delta U \neq 0,\ \Delta W \neq 0,\ \Delta Q \neq 0$
(IV) Isobaric	(D) $\Delta U = 0$

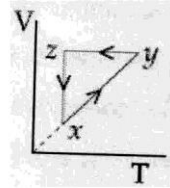
(a) I–B, II–D, III–A, IV–C
(b) I–B, II–A, III–D, IV–C
(c) I–A, II–A, III–B, IV–C
(d) I–A, II–B, III–D, IV–D

19. Three different processes that can occur in an ideal monatomic gas are shown in the P vs V diagram. The paths are labelled as $A \to B$, $A \to C$ and $A \to D$. The change in internal energies during these process are taken as E_{AB}, E_{AC} and E_{AD} and the workdone as W_{AB}, W_{AC} and W_{AD}. The correct relation between these parameters are

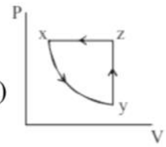


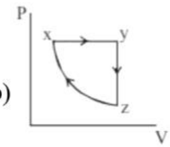
(a) $E_{AB} = E_{AC} = E_{AD}$, $W_{AB} > 0$, $W_{AC} = 0$, $W_{AD} < 0$
(b) $E_{AB} < E_{AC} < E_{AD}$, $W_{AB} > 0$, $W_{AC} > W_{AD}$
(c) $E_{AB} = E_{AC} < E_{AD}$, $W_{AB} > 0$, $W_{AC} = 0$, $W_{AD} < 0$
(d) $E_{AB} > E_{AC} > E_{AD}$, $W_{AB} < W_{AC} < W_{AD}$

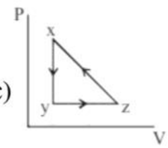
20. A thermodynamic cycle $xyzx$ is shown on a V- T diagram.

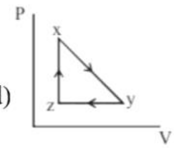


The P-V diagram that best describes this cycle is (Diagrams are schematic and not to scale)

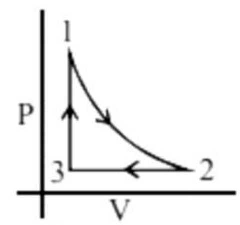
(a) 

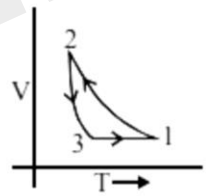
(b) 

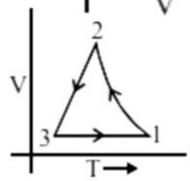
(c) 

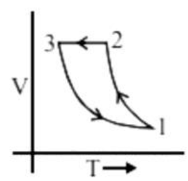
(d) 

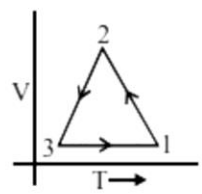
21. Which of the following is an equivalent cyclic process corresponding to the thermodynamic cyclic given in the figure? where, $1 \to 2$ is adiabatic. (Graphs are schematic and not to scale)



(a) 

(b) 

(c) 

(d) 

22. A heat engine is involved with exchange of heat of 1915 J, –40 J, +125 J and $-Q$J, during one cycle achieving an efficiency of 50.0%. The value of Q is

(a) 640 J (b) 400 J
(c) 980 J (d) 40 J

23. A Carnot engine having an efficiency of 1/10 is being used as a refrigerator. If the work done on the refrigerator is 10 J, the amount of heat absorbed from the reservoir at lower temperature is

(a) 99 J (b) 100 J
(c) 90 J (d) 1 J

SOLUTION

24. Two ideal Carnot engines operate in cascade (all heat given up by one engine is used by the other engine to produce work) between temperatures, T_1 and T_2. The temperature of the hot reservoir of the first engine is T_1 and the temperature of the cold reservoir of the second engine is T_2. T is temperature of the sink of first engine which is also the source for the second engine. How is T related to T_1 and T_2, if both the engines perform equal amount of work?

(a) $T = \sqrt{T_1T_2}$ (b) $T = 0$

(c) $T = \frac{T_1 + T_2}{2}$ (d) $T = \frac{2T_1T_2}{T_1 + T_2}$

25. Nitrogen gas is at $300°C$ temperature. The temperature (in K) at which the rms speed of a H_2 molecule would be equal to the rms speed of a nitrogen molecule, is ___ . (Molar mass of N_2 gas is 28g)

26. Initially a gas of diatomic molecules is contained in a cylinder of volume V_1 at a pressure P_1 and temperature 250K. Assuming that 25% of the molecules get dissociated causing a change in number of moles. The pressure of the resulting gas at temperature 2000K, when contained in a volume $2V_1$ is given by P_2. The ratio P_2/P_1 is

27. A closed vessel contains 0.1 mole of a monoatomic ideal gas at 200 K. If 0.05 mole of the same gas at 400 K is added to it, the final equilibrium temperature (in K) of the gas in the vessel will be close to______.

28. Starting at temperature 300 K, one mole of an ideal diatomic gas $(\gamma = 1.4)$ is first compressed adiabatically from volume V_1 to $V_2 = V_1/16$. It is then allowed to expand isobarically to volume $2V_2$. If all the processes are the quasi-static, then the final temperature of the gas (in K) is (to the nearest integer)

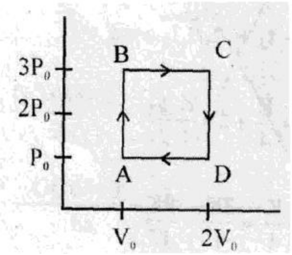
29. The change in the magnitude of the volume of an ideal gas when a small additional pressure ΔP is applied at a constant temperature, is the same as the change when the temperature is reduced by a small quantity ΔT at constant pressure. The initial temperature and pressure of the gas were 300 K and 2 atm respectively. If $|\Delta T| = C|\Delta P|$ then value of C in (K/atm) is_____.

30. A Carnot engine operates between two reservoirs of temperatures 900K and 300K. The engine performs 1200J of work per cycle. The heat energy (in J) delivered by the engine to the low temperature reservoir, in a cycle, is _____ .

31. An engine takes in 5 moles of air at 20°C and 1 atm, and compresses it adiabatically to $1/10^{th}$ of the original volume. Assuming air to be a diatomic ideal gas made up of rigid molecules, the change in its internal energy during this process comes out to be X kJ. The value of X to the nearest integer is

32. If minimum possible work is done by a refrigerator in converting 100 grams of water at 0°C to ice, how much heat (in calories) is released to the surrounding at temperature 27°C (Latent heat of ice = 80 Cal/gram) to the nearest integer?

33. An engine operates by taking a monatomic ideal gas through the cycle shown in the figure. The percentage efficiency of the engine is close to _____ .



SOLUTION

ANSWER KEY

1. d
2. c
3. d
4. b
5. a
6. d
7. c
8. d
9. c
10. d
11. c
12. a
13. b
14. c
15. b
16. c
17. d
18. a
19. a
20. b
21. b
22. c
23. c
24. c
25. 40 to 41
26. 5
27. 266 to 267
28. 1816 to 1820
29. 150
30. 600
31. 46
32. 8791
33. 19

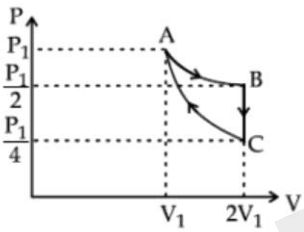
Feb Attempt

1. On the basis of kinetic theory of gases, the gas exerts pressure because its molecules :

   1. are attracted by the walls of container.
   2. continuously stick to the walls of container.
   3. continuously lose their energy till it reaches wall.
   4. suffer change in momentum when impinge on the walls of container.

2. If one mole of an ideal gas at (P_1, V_1) is allowed to expand reversibly and isothermally (A to B) its pressure is reduced to one-half of the original pressure (see figure). This is followed by a constant volume cooling till its pressure is reduced to one-fourth of the initial value ($B \rightarrow C$). Then it is restored to its initial state by a reversible adiabatic compression (C to A). The net workdone by the gas is equal to :

   1. 0
   2. RT ln 2
   3. $RT\left(\ln 2 - \dfrac{1}{2(\gamma-1)}\right)$
   4. $-\dfrac{RT}{2(\gamma-1)}$



3. The root mean square speed of molecules of a given mass of a gas at 27°C and 1 atmosphere pressure is 200 ms^{-1}. The root mean square speed of molecules of the gas at 127°C and 2 atmosphere pressure is $\dfrac{x}{\sqrt{3}}$ ms^{-1}. The value of x will be ________.

4. Match List I with List II.

	List I		List II
(a)	Isothermal	(i)	Pressure constant
(b)	Isochoric	(ii)	Temperature constant
(c)	Adiabatic	(iii)	Volume constant
(d)	Isobaric	(iv)	Heat content is constant

Choose the correct answer from the options given below :

   1. (a) → (iii), (b) → (ii), (c) → (i), (d) → (iv)
   2. (a) → (ii), (b) → (iv), (c) → (iii), (d) → (i)
   3. (a) → (ii), (b) → (iii), (c) → (iv), (d) → (i)
   4. (a) → (i), (b) → (iii), (c) → (ii), (d) → (iv)

SOLUTION

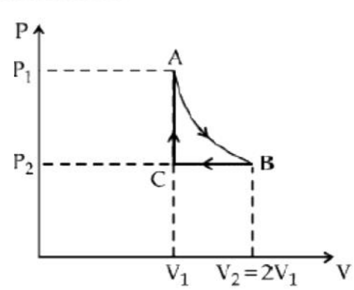
5. n mole of a perfect gas undergoes a cyclic process ABCA (see figure) consisting of the following processes.

$A \rightarrow B$: Isothermal expansion at temperature T so that the volume is doubled from V_1 to $V_2 = 2V_1$ and pressure changes from P_1 to P_2.

$B \rightarrow C$: Isobaric compression at pressure P_2 to initial volume V_1.

$C \rightarrow A$: Isochoric change leading to change of pressure from P_2 to P_1.

Total workdone in the complete cycle ABCA is :



1. $nRT\left(\ln 2 - \dfrac{1}{2}\right)$ 3. 0 2. nRTln 2 4. $nRT\left(\ln 2 + \dfrac{1}{2}\right)$

6. Given below are two statements :

Statement I : In a diatomic molecule, the rotational energy at a given temperature obeys Maxwell's distribution.

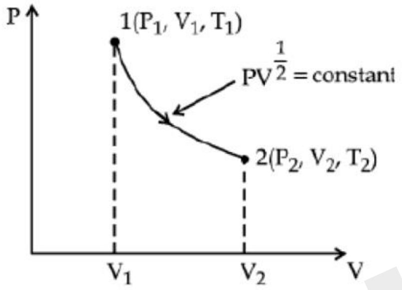
Statement II : In a diatomic molecule, the rotational energy at a given temperature equals the translational kinetic energy for each molecule.

In the light of the above statements, choose the correct answer from the options given below :

1. Statement I is false but Statement II is true.
2. Statement I is true but Statement II is false.
3. Both Statement I and Statement II are true.
4. Both Statement I and Statement II are false.

7. Thermodynamic process is shown below on a P-V diagram for one mole of an ideal gas. If $V_2 = 2V_1$ then the ratio of temperature T_2/T_1 is :

1. 2
2. $\sqrt{2}$
3. $\frac{1}{2}$
4. $\frac{1}{\sqrt{2}}$



8. A reversible heat engine converts one-fourth of the heat input into work. When the temperature of the sink is reduced by 52 K, its efficiency is doubled. The temperature in Kelvin of the source will be _________.

9. A diatomic gas, having $C_P = \frac{7}{2}R$ and $C_V = \frac{5}{2}R$, is heated at constant pressure. The ratio $dU : dQ : dW$:

1. 3 : 5 : 2
2. 5 : 7 : 3
3. 3 : 7 : 2
4. 5 : 7 : 2

10. A monoatomic gas of mass 4.0 u is kept in an insulated container. Container is moving with velocity 30 m/s. If container is suddenly stopped then change in temperature of the gas (R = gas constant) is $\frac{x}{3R}$. Value of x is _________.

11. In a certain thermodynamical process, the pressure of a gas depends on its volume as kV^3. The work done when the temperature changes from 100°C to 300°C will be ___ nR, where n denotes number of moles of a gas.

12. The internal energy (U), pressure (P) and volume (V) of an ideal gas are related as $U = 3PV + 4$. The gas is :

1. diatomic only.
2. either monoatomic or diatomic.
3. monoatomic only.
4. polyatomic only.

SOLUTION

13. The volume V of a given mass of monoatomic gas changes with temperature T according to the relation $V = KT^{2/3}$. The workdone when temperature changes by 90 K will be xR. The value of x is [R = universal gas constant]

15. A container is divided into two chambers by a partition. The volume of first chamber is 4.5 litre and second chamber is 5.5 litre. The first chamber contain 3.0 moles of gas at pressure 2.0 atm and second chamber contain 4.0 moles of gas at pressure 3.0 atm. After the partition is removed and the mixture attains equilibrium, then, the common equilibrium pressure existing in the mixture is $x \times 10^{-1}$ atm. Value of x is_.

14. 1 mole of rigid diatomic gas performs a work of $\frac{Q}{5}$ when heat Q is supplied to it. The molar heat capacity of the gas during this transformation is $\frac{xR}{8}$. The value of x is ________.

[R = universal gas constant]

March Attempt

1. The volume V of an enclosure contains a mixture of three gases, 16 g of oxygen, 28 g of nitrogen and 44 g of carbon dioxide at absolute temperature T. Consider R as universal gas constant. The pressure of the mixture of gases is :

(1) $\frac{88RT}{V}$ (2) $\frac{3RT}{V}$

(3) $\frac{5}{2}\frac{RT}{V}$ (4) $\frac{4RT}{V}$

2. In thermodynamics, heat and work are :

(1) Path functions

(2) Intensive thermodynamic state variables

(3) Extensive thermodynamic state variables

(4) Point functions

3. Calculate the value of mean free path (λ) for oxygen molecules at temperature 27°C and pressure 1.01×10^5 Pa. Assume the molecular diameter 0.3 nm and the gas is ideal. ($k = 1.38 \times 10^{-23}$ JK^{-1})

(1) 58 nm (2) 32 nm
(3) 86 nm (4) 102 nm

4. For an ideal heat engine, the temperature of the source is 127°C. In order to have 60% efficiency the temperature of the sink should be _______°C. (Round off to the Nearest Integer)

5. A polyatomic ideal gas has 24 vibrational modes. What is the value of γ ?

(1) 1.03 (2) 1.30
(3) 1.37 (4) 10.3

6. A Carnot's engine working between 400 K and 800 K has a work output of 1200 J per cycle. The amount of heat energy supplied to the engine from the source in each cycle is :

(1) 3200 J (2) 1800 J
(3) 1600 J (4) 2400 J

7. Two ideal polyatomic gases at temperatures T_1 and T_2 are mixed so that there is no loss of energy. If F_1 and F_2, m_1 and m_2, n_1 and n_2 be the degrees of freedom, masses, number of molecules of the first and second gas respectively, the temperature of mixture of these two gases is :

(1) $\frac{n_1T_1+n_2T_2}{n_1+n_2}$ (2) $\frac{n_1F_1T_1+n_2F_2T_2}{n_1F_1+n_2F_2}$

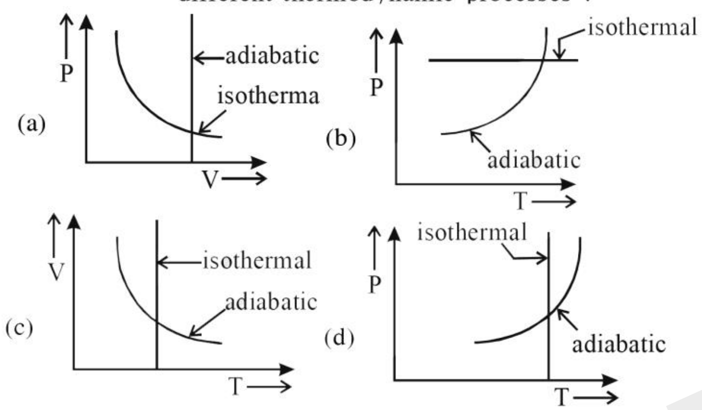
(3) $\frac{n_1F_1T_1+n_2F_2T_2}{F_1+F_2}$ (4) $\frac{n_1F_1T_1+n_2F_2T_2}{n_1+n_2}$

SOLUTION

8. If one mole of the polyatomic gas is having two vibrational modes and β is the ratio of molar specific heats for polyatomic gas $\left(\beta = \frac{C_P}{C_V}\right)$ then the value of β is :

(1) 1.02 (2) 1.2
(3) 1.25 (4) 1.35

9. Which one is the correct option for the two different thermodynamic processes ?



(1) (c) and (a) (2) (c) and (d)
(3) (a) only (4) (b) and (c)

10. What will be the average value of energy along one degree of freedom for an ideal gas in thermal equilibrium at a temperature T ? (k_B is Boltzmann constant)

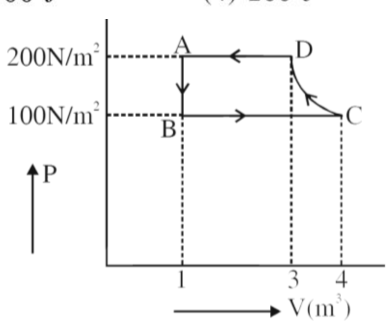
(1) $\frac{1}{2}k_BT$ (2) $\frac{2}{3}k_BT$

(3) $\frac{3}{2}k_BT$ (4) k_BT

11. The P-V diagram of a diatomic ideal gas system going under cyclic process as shown in figure. The work done during an adiabatic process CD is (use $\gamma = 1.4$) :

(1) –500 J (3) 400 J

(2) –400 J (4) 200 J



12. For an adiabatic expansion of an ideal gas, the fractional change in its pressure is equal to (where γ is the ratio of specific heats):

(1) $-\gamma\frac{dV}{V}$ (2) $-\gamma\frac{V}{dV}$

(3) $-\frac{1}{\gamma}\frac{dV}{V}$ (4) $\frac{dV}{V}$

13. An ideal gas in a cylinder is separated by a piston in such a way that the entropy of one part is S_1 and that of the other part is S_2. Given that $S_1 > S_2$. If the piston is removed then the total entropy of the system will be :

(1) $S_1 \times S_2$ (2) $S_1 - S_2$

(3) $\frac{S_1}{S_2}$ (4) $S_1 + S_2$

14. Consider a sample of oxygen behaving like an ideal gas. At 300 K, the ratio of root mean square (rms) velocity to the average velocity of gas molecule would be :
(Molecular weight of oxygen is 32 g/mol; $R = 8.3\ J\ K^{-1}\ mol^{-1}$)

(1) $\sqrt{\frac{3}{3}}$ (2) $\sqrt{\frac{8}{3}}$

(3) $\sqrt{\frac{3\pi}{8}}$ (4) $\sqrt{\frac{8\pi}{3}}$

<u>July Attempt</u>

1. The amount of heat needed to raise the temperature of 4 moles of a rigid diatomic gas from 0°C to 50°C when no work is done is _______. (R is the universal gas constant)

(1) 250 R (2) 750 R (3) 175 R (4) 500 R

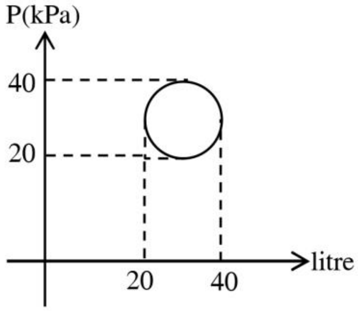
2. Consider a mixture of gas molecule of types A, B and C having masses $m_A < m_B < m_C$. The ratio of their root mean square speeds at normal temperature and pressure is :

(1) $v_A = v_B = v_C = 0$ (3) $v_A = v_B \neq v_C$

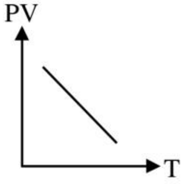
(2) $\frac{1}{v_A} > \frac{1}{v_B} > \frac{1}{v_C}$ (4) $\frac{1}{v_A} < \frac{1}{v_B} < \frac{1}{v_C}$

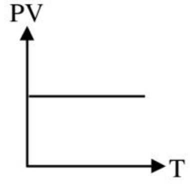
SOLUTION

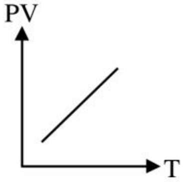
3. In the reported figure, heat energy absorbed by a system in going through a cyclic process is _______ πJ.

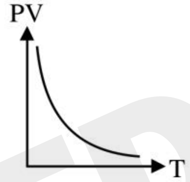


4. Which of the following graphs represent the behavior of an ideal gas ? Symbols have their usual meaning.

(1)


(2)


(3)


(4)


5. The correct relation between the degrees of freedom f and the ratio of specific heat γ is :

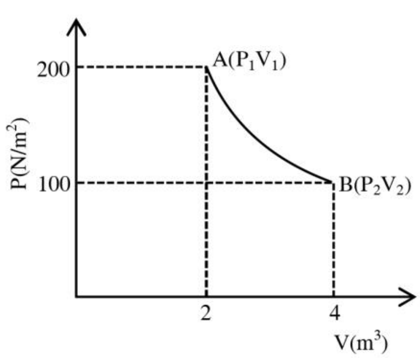
(1) $f=\dfrac{2}{\gamma-1}$ (2) $f=\dfrac{2}{\gamma+1}$

(3) $f=\dfrac{\gamma+1}{2}$ (4) $f=\dfrac{1}{\gamma+1}$

6. One mole of an ideal gas at 27ºC is taken from A to B as shown in the given PV indicator diagram. The work done by the system will be_____ $\times 10^{-1}$ J.

[Given : R = 8.3 J / mole K, ln2 = 0.6931]

(Round off to the nearest integer)



7. What will be the average value of energy for a monoatomic gas in thermal equilibrium at temperature T ?

(1) $\frac{2}{3}k_BT$ (2) k_BT (3) $\frac{3}{2}k_BT$ (4) $\frac{1}{2}k_BT$

8. For a gas $C_P - C_V = R$ in a state P and $C_P - C_V = 1.10\ R$ in a state Q, T_P and T_Q are the temperatures in two different states P and Q respectively. Then

(1) $T_P = T_Q$ (2) $T_P < T_Q$

(3) $T_P = 0.9\ T_Q$ (4) $T_P > T_Q$

9. A monoatomic ideal gas, initially at temperature T_1 is enclosed in a cylinder fitted with a frictionless piston. The gas is allowed to expand adiabatically to a temperature T_2 by releasing the piston suddenly. If l_1 and l_2 are the lengths of the gas column, before and after the expansion respectively, then the value of $\dfrac{T_1}{T_2}$ will be :

(1) $\left(\dfrac{l_1}{l_2}\right)^{\frac{2}{3}}$ (2) $\left(\dfrac{l_2}{l_1}\right)^{\frac{2}{3}}$

(3) $\dfrac{l_2}{l_1}$ (4) $\dfrac{l_1}{l_2}$

10. A heat engine has an efficiency of $\frac{1}{6}$. When the temperature of sink is reduced by 62°C, its efficiency get doubled. The temperature of the source is :

(1) 124°C (2) 37°C

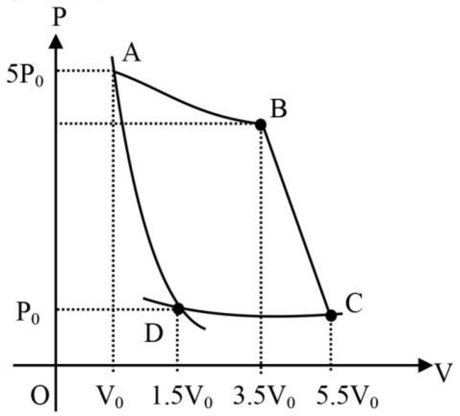
(3) 62°C (4) 99°C

11. A system consists of two types of gas molecules A and B having same number density 2×10^{25} / m^3. The diameter of A and B are 10 Å and 5 Å respectively. They suffer collision at room temperature. The ratio of average distance covered by the molecule A to that of B between two successive collision is _______ $\times 10^{-2}$

SOLUTION

12. The number of molecules in one litre of an ideal gas at 300 K and 2 atmospheric pressure with mean kinetic energy 2×10^{-9} J per molecules is :
(1) 0.75×10^{11} (2) 3×10^{11}
(3) 1.5×10^{11} (4) 6×10^{11}

13. In the reported figure, there is a cyclic process ABCDA on a sample of 1 mol of a diatomic gas. The temperature of the gas during the process $A \rightarrow B$ and $C \rightarrow D$ are T_1 and T_2 ($T_1 > T_2$) respectively.



Choose the correct option out of the following for work done if processes BC and DA are adiabatic.
(1) $W_{AB} = W_{DC}$ (2) $W_{AD} = W_{BC}$
(3) $W_{BC} + W_{DA} > 0$ (4) $W_{AB} < W_{CD}$

14. One mole of an ideal gas is taken through an adiabatic process where the temperature rises from 27°C to 37°C. If the ideal gas is composed of polyatomic molecule that has 4 vibrational modes, which of the following is true?
[$R = 8.314$ J mol^{-1} k^{-1}]
(1) work done by the gas is close to 332 J
(2) work done on the gas is close to 582 J
(3) work done by the gas is close to 582 J
(4) work done on the gas is close to 332 J

15. Two Carnot engines A and B operate in series such that engine A absorbs heat at T_1 and rejects heat to a sink at temperature T. Engine B absorbs half of the heat rejected by Engine A and rejects heat to the sink at T_3. When workdone in both the cases is equal, to value of T is :
(1) $\frac{2}{3}T_1 + \frac{3}{2}T_3$ (2) $\frac{1}{3}T_1 + \frac{2}{3}T_3$
(3) $\frac{3}{2}T_1 + \frac{1}{3}T_3$ (4) $\frac{2}{3}T_1 + \frac{1}{3}T_3$

August Attempt

1. The rms speeds of the molecules of Hydrogen, Oxygen and Carbondioxide at the same temperature are V_H, V_O and V_C respectively then :
(1) $V_H > V_O > V_C$ (2) $V_C > V_O > V_H$
(3) $V_H = V_O > V_C$ (4) $V_H = V_O = V_C$

2. A cylindrical container of volume 4.0×10^{-3} m^3 contains one mole of hydrogen and two moles of carbon dioxide. Assume the temperature of the mixture is 400 K. The pressure of the mixture of gases is :
[Take gas constant as 8.3 J mol^{-1} K^{-1}]
(1) 249×10^1 Pa (2) 24.9×10^3 Pa
(3) 24.9×10^5 Pa (4) 24.9 Pa

3. A refrigerator consumes an average 35 W power to operate between temperature –10°C to 25°C. If there is no loss of energy then how much average heat per second does it transfer ?
(1) 263 J/s (2) 298 J/s (3) 350 J/s (4) 35 J/s

4. A balloon carries a total load of 185 kg at normal pressure and temperature of 27°C. What load will the balloon carry on rising to a height at which the barometric pressure is 45 cm of Hg and the temperature is –7°C. Assuming the volume constant ?
(1) 181.46 kg (2) 214.15 kg.
(3) 219.07 kg (4) 123.54 kg

5. An ideal gas is expanding such that PT^3 = constant. The coefficient of volume expansion of the gas is :
(1) $\frac{1}{T}$ (2) $\frac{2}{T}$
(3) $\frac{4}{T}$ (4) $\frac{3}{T}$

6. If the rms speed of oxygen molecules at 0°C is 160 m/s, find the rms speed of hydrogen molecules at 0°C.
(1) 640 m/s (2) 40 m/s
(3) 80 m/s (4) 332 m/s

SOLUTION

7. A heat engine operates between a cold reservoir at temperature $T_2 = 400$ K and a hot reservoir at temperature T_1. It takes 300 J of heat from the hot reservoir and delivers 240 J of heat to the cold reservoir in a cycle. The minimum temperature of the hot reservoir has to be _________K.

8. A reversible engine has an efficiency of $\frac{1}{4}$. If the temperature of the sink is reduced by 58°C, its efficiency becomes double. Calculate the temperature of the sink :

(1) 174°C (2) 280°C

(3) 180.4°C (4) 382°C

9. For an ideal gas the instantaneous change in pressure 'p' with volume 'v' is given by the equation $\frac{dp}{dv} = -ap$. If $p = p_0$ at $v = 0$ is the given boundary condition, then the maximum temperature one mole of gas can attain is :

(Here R is the gas constant)

(1) $\frac{p_0}{aeR}$ (2) $\frac{ap_0}{eR}$

(3) infinity (4) 0°C

10. A mixture of hydrogen and oxygen has volume 500 cm^3, temperature 300 K, pressure 400 kPa and mass 0.76 g. The ratio of masses of oxygen to hydrogen will be :-

(1) 3 : 8 (2) 3 : 16

(3) 16 : 3 (4) 8 : 3

11. A sample of gas with $\gamma = 1.5$ is taken through an adiabatic process in which the volume is compressed from 1200 cm^3 to 300 cm^3. If the initial pressure is 200 kPa. The absolute value of the workdone by the gas in the process =_____J.

12. The temperature of 3.00 mol of an ideal diatomic gas is increased by 40.0 °C without changing the pressure of the gas. The molecules in the gas rotate but do not oscillate. If the ratio of change in internal energy of the gas to the amount of workdone by the gas is $\frac{x}{10}$. Then the value of x (round off to the nearest integer) is _______.

(Given $R = 8.31$ J mol^{-1} K^{-1})

13. The average translational kinetic energy of N_2 gas molecules at ....°C becomes equal to the K.E. of an electron accelerated from rest through a potential difference of 0.1 volt.

(Given $k_B = 1.38 \times 10^{-23}$ J/K)

(Fill the nearest integer).

SOLUTION

ANSWER KEY

Feb Attempt

1. 4
2. 3
3. 400
4. 3
5. 1
6. 2
7. 2
8. 208
9. 4
10. Bonus
11. 50
12. 4
13. 60
14. 25
15. 25

March Attempt

1. 3
2. 1
3. 4
4. Dropped
5. 1
6. 4
7. 2
8. 2
9. 2
10. 1
11. 1
12. 1
13. 4
14. 3

July Attempt

1. 4
2. 4
3. 100
4. 3
5. 1
6. 17258
7. 3
8. 4
9. 2
10. 4
11. 25
12. 3
13. 2
14. 2
15. 4

August Attempt

1. 1
2. 3
3. 1
4. 4
5. 3
6. 1
7. 500
8. Bonus
9. 1
10. 3
11. 480
12. 25
13. 500

1. A Carnot engine whose heat sinks at 27°C, has an efficiency of 25%. By how many degrees should the temperature of the source be changed to increase the efficiency by 100% of the original efficiency ?
(A) Increases by 18°C (B) Increase by 200°C
(C) Increase by 120°C (D) Increase by 73°

2. 0.056 kg of Nitrogen is enclosed in a vessel at a temperature of 127°C. The amount of heat required to double the speed of its molecules is _____ k cal. (Take R = 2 cal $mole^{-1}K^{-1}$)

3. A Carnot engine take 5000 kcal of heat from a reservoir at 727°C and gives heat to a sink at 127°C. The work done by the engine is :
(A) 3×10^6 J (B) Zero
(C) 12.6×10^6 J (D) 8.4×10^6 J

4. A monoatomic gas performs a work of $\frac{Q}{4}$ where Q is the heat supplied to it. The molar heat capacity of the gas will be ________R during this transformation.

Where R is the gas constant.

5. The relation between root mean square speed (v_{rms}) and most probable speed (v_p) for the molar mass M of oxygen gas molecule at the temperature of 300 K will be :-

(A) $v_{rms} = \sqrt{\frac{2}{3}}v_p$ (B) $v_{rms} = \sqrt{\frac{3}{2}}v_p$

(C) $v_{rms} = v_p$ (D) $v_{rms} = \sqrt{\frac{1}{3}}v_p$

6. A steam engine intakes 50g of steam at 100°C per minute and cools it down to 20°C. If latent heat of vaporization of steam is 540 cal g^{-1}, then the heat rejected by the steam engine per minute is ______ $\times 10^3$ cal.

7. The ratio of specific heats $\left(\frac{C_P}{C_V}\right)$ in terms of degree of freedom (f) is given by:

(A) $\left(1+\frac{f}{3}\right)$ (B) $\left(1+\frac{2}{f}\right)$

(C) $\left(1+\frac{f}{2}\right)$ (D) $\left(1+\frac{1}{f}\right)$

8. When a gas filled in a closed vessel is heated by raising the temperature by 1°C, its pressure increase by 0.4%. The initial temperature of the gas is______ K.

9. The efficiency of a Carnot's engine, working between steam point and ice point, will be :
(A) 26.81% (B) 37.81%
(C) 47.81% (D) 57.81%

10. A thermally insulated vessel contains an ideal gas of molecular mass M and ratio of specific heats 1.4. Vessel is moving with speed v and is suddenly brought to rest. Assuming no heat is lost to the surrounding and vessel temperature of the gas increases by : (R = universal gas constant)

(A) $\frac{Mv^2}{7R}$ (C) $2\frac{Mv^2}{7R}$

(B) $\frac{Mv^2}{5R}$ (D) $7\frac{Mv^2}{5R}$

11. A flask contains argon and oxygen in the ratio of 3:2 in mass and the mixture is kept at 27°C. The ratio of their average kinetic energy per molecule respectively will be :
(A) 3 : 2 (B) 9 : 4 (C) 2 : 3 (D) 1 : 1

SOLUTION

12. A heat engine operates with the cold reservoir at temperature 324 K.

The minimum temperature of the hot reservoir, if the heat engine takes 300 J heat from the hot reservoir and delivers 180 J heat to the cold reservoir per cycle, is ___________K.

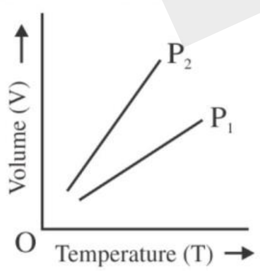
13. A mixture of hydrogen and oxygen has volume 2000 cm^3, temperature 300 K, pressure 100 kPa and mass 0.76 g The ratio of number of moles of hydrogen to number of moles of oxygen in the mixture will be :

(A) $\frac{1}{3}$ (B) $\frac{3}{1}$

(C) $\frac{1}{16}$ (D) $\frac{16}{1}$

14. In a carnot engine, the temperature of reservoir is 527ºC and that of sink is 200 K. If the workdone by the engine when it transfers heat from reservoir to sink is 12000 kJ, the quantity of heat absorbed by the engine from reservoir is _______ $\times 10^6$ J.

15. For a perfect gas, two pressures P_1 and P_2 are shown in figure. The graph shows:



(A) $P_1 > P_2$

(B) $P_1 < P_2$

(C) $P_1 = P_2$

(D) Insufficient data to draw any conclusion

16. According to kinetic theory of gases,

A. The motion of the gas molecules freezes at 0ºC

B. The mean free path of gas molecules decreases if the density of molecules is increased.

C. The mean free path of gas molecules increases if temperature is increased keeping pressure constant.

D. Average kinetic energy per molecule per degree of freedom is $\frac{3}{2}k_BT$ (for monoatomic gases)

Choose the most appropriate answer from the options given below:

(A) A and C only (B) B and C only

(C) A and B only (D) C and D only

17. A diatomic gas ($\gamma = 1.4$) does 400 J of work when it is expanded isobarically. The heat given to the gas in the process is _______ J.

18. Given below are two statement :

Statement – I : What μ amount of an ideal gas undergoes adiabatic change from state (P_1, V_1, T_1) to state (P_2, V_2, T_2), the work done is $W = \frac{1R(T_2 - T_1)}{1-\gamma}$, where $\gamma = \frac{C_P}{C_V}$ and R = universal gas constant,

Statement — II: In the above case. when work is done on the gas. the temperature of the gas would rise.

Choose the correct answer from the options given below:

(A) Both statement—I and statement-II are true.

(B) Both statement—I and statement-II are false.

(C) Statement-I is true but statement-II is false.

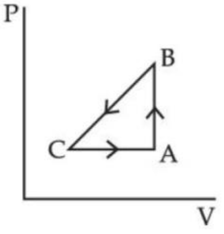
(D) Statement-I is false but statement-II is true.

19. The total internal energy of two mole monoatomic ideal gas at temperature T = 300 K will be J.

(Given R = 8.31 J/mol.K)

SOLUTION

20. A sample of an ideal gas is taken through the cyclic process ABCA as shown in figure. It absorbs, 40 J of heat during the part AB, no heat during BC and rejects 60J of heat during CA. A work 50J is done on the gas during the part BC. The internal energy of the gas at A is 1560J. The work done by the gas during the part CA is:



(A) 20 J (B) 30 J

(C) –30J (D) –60 J

21. What will be the effect on the root mean square velocity of oxygen molecules if the temperature is doubled and oxygen molecule dissociates into atomic oxygen?

(A) The velocity of atomic oxygen remains same

(B) The velocity of atomic oxygen doubles

(C) The velocity of atomic oxygen becomes half

(D) The velocity of atomic oxygen becomes four times

22. A cylinder of fixed capacity of 44.8 litres contains helium gas at standard temperature and pressure. The amount of heat needed to raise the temperature of gas in the cylinder by 20.0°C will be :

(Given gas constant $R = 8.3\ JK^{-1}\text{-}mol^{-1}$)

(A) 249 J (B) 415 J

(C) 498 J (D) 830 J

23. 300 cal. of heat is given to a heat engine and it rejects 225 cal. of heat. If source temperature is 227°C, then the temperature of sink will be __ ^{0}C.

24. Starting with the same initial conditions, an ideal gas expands from volume V_1 to V_2 in three different ways. The work done by the gas is W_1 if the process is purely isothermal. W_2. if the process is purely adiabatic and W_3 if the process is purely isobaric. Then, choose the coned option

(A) $W_1 < W_2 < W_3$ (B) $W_2 < W_3 < W_1$

(C) $W_3 < W_1 < W_2$ (D) $W_2 < W_1 < W_3$

25. A vessel contains 16g of hydrogen and 128 g of oxygen at standard temperature and pressure. The volume of the vessel in cm^3 is :

(A) 72×10^5 (B) 32×10^5

(C) 27×10^4 (D) 54×10^4

SOLUTION

Answer Key

1. B
2. 12
3. C
4. 2
5. B
6. 31
7. B
8. 250
9. A
10. B
11. D
12. 540
13. B
14. 16
15. A
16. B
17. 1400
18. A
19. 7479
20. B
21. B
22. C
23. 102
24. D
25. C

1. A certain amount of gas of volume V at 27°C temperature and pressure 2×10^7 Nm^{-2} expands isothermally until its volume gets doubled. Later it expands adiabatically until its volume gets redoubled. The final pressure of the gas will be (Use $\gamma = 1.5$)

(A) 3.536×10^5 Pa (B) 3.536×10^6 Pa

(C) 1.25×10^6 Pa (D) 1.25×10^5 Pa

2. Following statements are given :

(1) The average kinetic energy of a gas molecule decreases when the temperature is reduced.

(2) The average kinetic energy of a gas molecule increases with increase in pressure at constant temperature.

(3) The average kinetic energy of a gas molecule decreases with increases in volume.

(4) Pressure of a gas increases with increase in temperature at constant pressure.

(5) The volume of gas decreases with increase in temperature.

Choose the correct answer from the options given below :

(A) (1) and (4) only (B) (1), (2) and (4) only

(C) (2) and (4) only (D) (1), (2) and (5) only

3. Let η_1 is the efficiency of an engine at $T_1 = 447°C$ and $T_2 = 147°C$ while η_2 is the efficiency at $T_1 = 947°C$ and $T_2 = 47°C$. The ratio $\frac{\eta_1}{\eta_2}$ will be :

(A) 0.41 (B) 0.56

(C) 0.73 (D) 0.70

4. 7 mole of certain monoatomic ideal gas undergoes a temperature increase of 40K at constant pressure. The increase in the internal energy of the gas in this process is

(Given $R = 8.3\ JK^{-1}mol^{-1}$)

(A) 5810 J (B) 3486 J

(C) 11620J (D) 6972 J

5. A monoatomic gas at pressure P and volume V is suddenly compressed to one eighth of its original volume. The final pressure at constant entropy will be:

(A) P (B) 8P

(C) 32P (D) 64 P

6. A gas has n degrees of freedom. The ratio of specific heat of gas at constant volume to the specific heat of gas at constant pressure will be :

(A) $\frac{n}{n+2}$ (B) $\frac{n+2}{n}$

(C) $\frac{n}{2n+2}$ (D) $\frac{n}{n-2}$

7. Same gas is filled in two vessels of the same volume at the same temperature. If the ratio of the number of molecules is 1:4, then

A. The r.m.s. velocity of gas molecules in two vessels will be the same.

B. The ratio of pressure in these vessels will be 1 : 4

C. The ratio of pressure will be 1 : 1

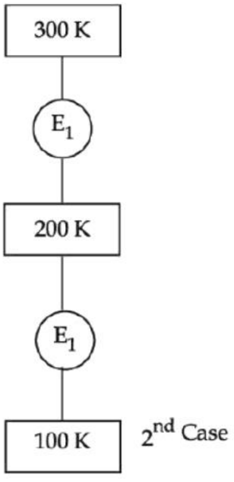
D. The r.m.s. velocity of gas molecules in two vessels will be in the ratio of 1 : 4

(A) A and C only (B) B and D only

(C) A and B only (D) C and D only

SOLUTION

8. In 1^{st} case, Carnot engine operates between temperatures 300 K and 100 K. In 2^{nd} case, as shown in the figure, a combination of two engines is used. The efficiency of this combination (in 2^{nd} case) will be :



(A) same as the 1^{st} case

(B) always greater than the 1^{st} case

(C) always less than the 1^{st} case

(D) may increase or decrease with respect to the 1^{st} case

9. Which statements are correct about degrees of freedom?

A. A molecule with n degrees of freedom has n^2 different ways of storing energy.

B. Each degree of freedom is associated with $\frac{1}{2}RT$ average energy per mole.

C. A monoatomic gas molecule has 1 rotational degree of freedom where as diatomic molecule has 2 rotational degrees of freedom

D. CH_4 has a total to 6 degrees of freedom

Choose the correct answer from the option given below:

(A) B and C only (B) B and D only

(C) A and B only (D) C and D only

10. A Carnot engine has efficiency of 50%. If the temperature of sink is reduced by 40°C, its efficiency increases by 30%. The temperature of the source will be :

(A) 166.7 K (B) 255.1 K

(C) 266.7 K (D) 367.7 K

11. Given below are two statements :

Statement I : The average momentum of a molecule in a sample of an ideal gas depends on temperature.

Statement II : The rms speed of oxygen molecules in a gas is v. If the temperature is doubled and the oxygen molecules dissociate into oxygen atoms, the rms speed will become 2v.

In the light of the above statements, choose the correct answer from the options given below :

(A) Both Statement I and Statement II are true

(B) Both Statement I and Statement II are false

(C) Statement I is true but Statement II is false

(D) Statement I is false but Statement II is true

12. A vessel contains 14 g of nitrogen gas at a temperature of 27°C. The amount of heat to be transferred to the gap to double the r.m.s. speed of its molecules will be : (Take $R = 8.32\ J\ mol^{-1}k^{-1}$)

(A) 2229 J (B) 5616 J

(C) 9360 J (D) 13,104 J

13. At a certain temperature, the degrees of freedom per molecule for gas is 8. The gas performs 150 J of work when it expands under constant pressure. The amount of heat absorbed by the gas will be …….. J.

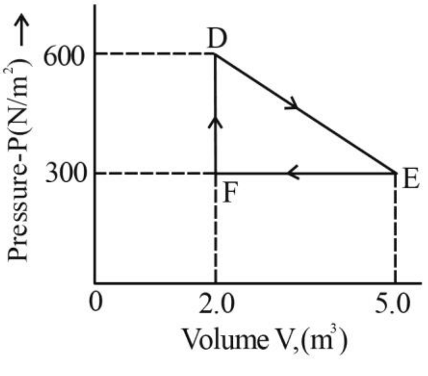
SOLUTION

14. The pressure P_1 and density d_1 of diatomic gas $\left(\gamma = \frac{7}{5}\right)$ changes suddenly to $P_2(>P_1)$ and d_2 respectively during an adiabatic process. The temperature of the gas increases and becomes _________ times of its initial temperature.

(given $\frac{d_2}{d_1} = 32$)

15. One mole of a monoatomic gas is mixed with three moles of a diatomic gas. The molecular specific heat of mixture at constant volume is $\frac{\alpha^2}{4}R$ J/mol K; then the value of α will be _______. (Assume that the given diatomic gas has no vibrational mode.)

16. A thermodynamic system is taken from an original state D to an intermediate state E by the linear process shown in the figure. Its volume is then reduced to the original volume from E to F by an isobaric process. The total work done by the gas from D to E to F will be



(A) –450 J
(B) 450 J
(C) 900 J
(D) 1350 J

17. The root mean square speed of smoke particles of mass 5×10^{-17} kg in their Brownian motion in air at NTP is approximately. [Given $k = 1.38 \times 10^{-23}$ JK^{-1}]

(A) 60 mm s^{-1}
(B) 12 mm s^{-1}
(C) 15 mm s^{-1}
(D) 36 mm s^{-1}

SOLUTION

ANSWER KEY

1. B
2. A (in statement 4 it should be Const Volume)
3. B
4. B
5. C
6. A
7. C
8. A
9. B
10. C
11. D
12. C
13. 750
14. 4
15. 3
16. B
17. C

1. A sample of gas at temperature T is adiabatically expanded to double its volume. The work done by the gas in the process is $\left(\text{given}, \gamma = \frac{3}{2}\right)$:

(1) $W = TR\,[\sqrt{2} - 2]$

(2) $W = \frac{T}{R}[\sqrt{2} - 2]$

(3) $W = \frac{R}{T}[2 - \sqrt{2}]$

(4) $W = RT\,[2 - \sqrt{2}]$

2. The average kinetic energy of a molecule of the gas is

(1) proportional to absolute temperature

(2) proportional to volume

(3) proportional to pressure

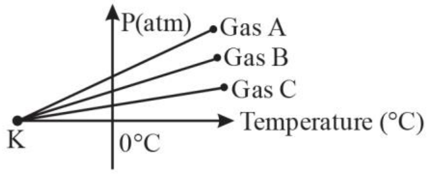
(4) dependent on the nature of the gas

3. A Carnot engine operating between two reservoirs has efficiency $\frac{1}{3}$. When the temperature of cold reservoir raised by x, its efficiency decreases to $\frac{1}{6}$. The value of x, if the temperature of hot reservoir is 99° C, will be:

(1) 16.5 K (2) 33 K

(3) 66 K (4) 62 K

4. For three low density gases A, B, C pressure versus temperature graphs are plotted while keeping them at constant volume, as shown in the figure.



The temperature corresponding to the point 'K' is:

(1) –273°C (2) –100°C

(3) –373°C (4) –40°C

5. 1g of a liquid is converted to vapour at 3×10^5 Pa pressure. If 10% of the heat supplied is used for increasing the volume by 1600 cm^3 during this phase change, then the increase in internal energy in the process will be :

(1) 4320 J (2) 432000 J

(3) 4800 J (4) 4.32×10^8 J

6. Given below are two statements :

Statements I : The temperature of a gas is – 73°C. When the gas is heated to 527°C, the root mean square speed of the molecules is doubled.

Statement II : The product of pressure and volume of an ideal gas will be equal to translational kinetic energy of the molecules.

In the light of the above statements, choose the **correct** answer from the options given below :

(1) Both statement I and Statement II are true

(2) Statement I is true but Statement II is false

(3) Both Statement I and Statement II are false

(4) Statement I is false but Statement II is true

7. Let γ_1 be the ratio of molar specific heat at constant pressure and molar specific heat at constant volume of a monoatomic gas and γ_2 be the similar ratio of diatomic gas. Considering the diatomic gas molecule as a rigid rotator, the ratio, $\frac{\gamma_1}{\gamma_2}$ is

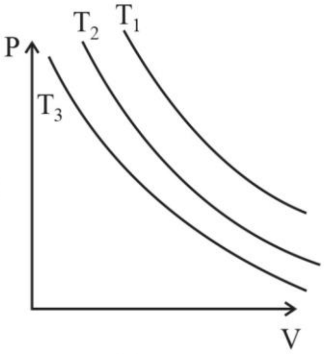
(1) $\frac{27}{35}$ (2) $\frac{35}{27}$

(3) $\frac{25}{21}$ (4) $\frac{21}{25}$

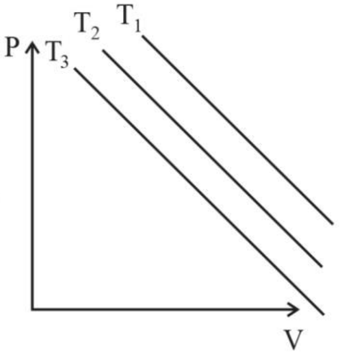
SOLUTION

8. In an Isothermal change, the change in pressure and volume of a gas can be represented for three different temperature; $T_3 > T_2 > T_1$ as :

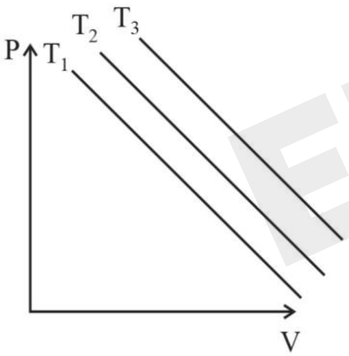
(1)



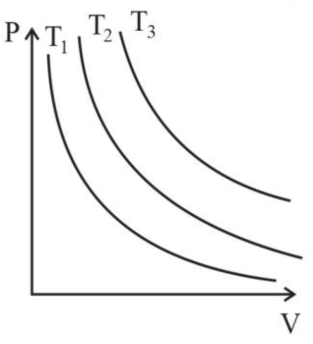
(2)



(3)



(4)



9. A Carnot engine with efficiency 50% takes heat from a source at 600 K. In order to increase the efficiency to 70%, keeping the temperature of sink same, the new temperature of the source will be :

(1) 360 K (2) 1000 K

(3) 900 K (4) 300 K

10. The root mean square velocity of molecules of gas is

(1) Proportional to square of temperature (T^2).

(2) Inversely proportional to square root of temperature $\sqrt{\frac{1}{T}}$.

(3) Proportional to square root of temperature $\sqrt{T}$.

(4) Proportional to temperature (T).

11. According to law of equipartition of energy the molar specific heat of a diatomic gas at constant volume where the molecule has one additional vibrational mode is :-

(1) $\frac{9}{2}R$ (2) $\frac{5}{2}R$ (3) $\frac{3}{2}R$ (4) $\frac{7}{2}R$

12. Match List I with List II :

	List I		List II
A.	Isothermal Process	I.	Work done by the gas decreases internal energy
B.	Adiabatic Process	II.	No change in internal energy
C.	Isochoric Process	III.	The heat absorbed goes partly to increase internal energy and partly to do work
D.	Isobaric Process	IV.	No work is done on or by the gas

Choose the correct answer from the options given below :

(1) A-II, B-I, C-III, D-IV

(2) A-II, B-I, C-IV, D-III

(3) A-I, B-II, C-IV, D-III

(4) A-I, B-II, C-III, D-IV

SOLUTION

13. Given below are two statements. One is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : If dQ and dW represent the heat supplied to the system and the work done on the system respectively. Then according to the first law of thermodynamics $dQ = dU - dW$.

Reason R : First law of thermodynamics is based on law of conservation of energy.

In the light of the above statements, choose the correct answer from the option given below :

(1) A is correct but R is not correct

(2) A is not correct but R is correct

(3) Both A and R are correct and R is the correct explanation of A

(4) Both A and R are correct but R is not the correct explanation of A

14. A bicycle tyre is filled with air having pressure of 270 kPa at 27ºC. The approximate pressure of the air in the tyre when the temperature increases to 36ºC is

(1) 270 kPa (2) 262 KPa

(3) 278 kPa (4) 360 kPa

15 At 300 K, the rms speed of oxygen molecules is $\sqrt{\frac{\alpha+5}{\alpha}}$ times to that of its average speed in the gas. Then, the value of α will be (used $\pi = \frac{22}{7}$)

(1) 32 (2) 28

(3) 24 (4) 27

16. The pressure (P) and temperature (T) relationship of an ideal gas obeys the equation PT^2 = constant. The volume expansion coefficient of the gas will be:

(1) $3T^2$ (2) $\frac{3}{T^2}$

(3) $\frac{3}{T^3}$ (4) $\frac{3}{T}$

17. Heat is given to an ideal gas in an isothermal process.
A. Internal energy of the gas will decrease.
B. Internal energy of the gas will increase.
C. Internal energy of the gas will not change.
D. The gas will do positive work.
E. The gas will do negative work.
Choose the **correct** answer from the options given below :

(1) A and E only (2) B and D only

(3) C and E only (4) C and D only

18. A flask contains hydrogen and oxygen in the ratio of 2 : 1 by mass at temperature 27°C. The ratio of average kinetic energy per molecule of hydrogen and oxygen respectively is :

(1) 2 : 1 (2) 1 : 1

(3) 1 : 4 (4) 4 : 1

19. Given below are **two** statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : Efficiency of a reversible heat engine will be highest at –273°C temperature of cold reservoir.

Reason R : The efficiency of Carnot's engine depends not only on temperature of cold reservoir but it depends on the temperature of hot reservoir too and is given as $\eta = \left(1 - \frac{T_2}{T_1}\right)$.

In the light of the above statements, choose the **correct** answer from the options given below :

(1) **A** is true but **R** is false

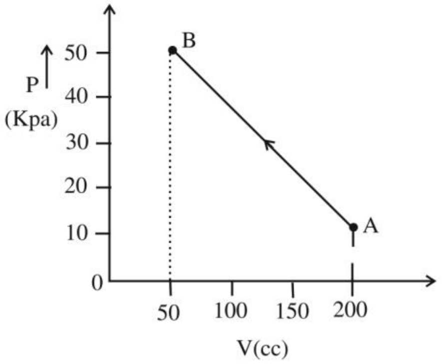
(2) Both **A** and **R** are true but **R** is **NOT** the correct explanation of **A**

(3) **A** is false but **R** is true

(4) Both **A** and **R** are true and **R** is the correct explanation of **A**

SOLUTION

20. The pressure of a gas changes linearly with volume from A to B as shown in figure. If no heat is supplied to or extracted from the gas then change in the internal energy of the gas will be



(1) 6 J (2) Zero
(3) –4.5J (4) 4.5 J

21. The correct relation between $\gamma = \frac{C_p}{c_v}$ and temperature T is :

(1) $\gamma \propto \frac{1}{\sqrt{T}}$ (2) $\gamma \propto T^o$
(3) $\gamma \propto \frac{1}{T}$ (4) $\gamma \propto T$

22. Heat energy of 735 J is given to a diatomic gas allowing the gas to expand at constant pressure. Each gas molecule rotates around an internal axis but do not oscillate. The increase in the internal energy of the gas will be:

(1) 525 J (2) 441 J
(3) 572 J (4) 735 J

23. A hypothetical gas expands adiabatically such that its volume changes from 08 litres to 27 litres. If the ratio of final pressure of the gas to initial pressure of the gas is $\frac{16}{81}$. Then the ratio of $\frac{C_P}{C_V}$ will be.

(1) $\frac{4}{3}$ (2) $\frac{3}{1}$
(3) $\frac{1}{2}$ (4) $\frac{3}{2}$

SOLUTION

ANSWER KEY

1. 4
2. 1
3. 4
4. 1
5. 1
6. 2
7. 3
8. 4
9. 2
10. 3
11. 4
12. 2
13. 3
14. 3
15. 2
16. 4
17. 4
18. 2
19. 4
20. 4
21. 2
22. 1
23. 1

1. The number of air molecules per cm^3 increased from 3×10^{19} to 12×10^{19}. The ratio of collision frequency of air molecules before and after the increase in number respectively is
(1) 1.25 (2) 0.25
(3) 0.75 (4) 0.50

2. A source supplies heat to a system at the rate of 1000 W. If the system performs work at a rate of 200 W. The rate at which internal energy of the system increases
(1) 1200 W (2) 600 W
(3) 500 W (4) 800 W

3. The temperature of an ideal gas is increased from 200 K to 800 K. If r.m.s. speed of gas at 200K is v_0. Then, r.m.s. speed of the gas at 800 K will be:
(1) v_0 (2) $4v_0$
(3) $\frac{v_0}{4}$ (4) $2v_0$

4. **Statement I:** If heat is added to a system, its temperature must increase.
Statement II: If positive work is done by a system in a thermodynamic process, its volume must increase.
In the light of the above statements, choose the correct answer from the options given below
(1) Statement I is true but Statement II is false
(2) Both Statement I and Statement II are true
(3) Both Statement I and Statement II are false
(4) Statement I is false but Statement II is true

5. The temperature at which the kinetic energy of oxygen molecules becomes double than its value at 27°C is
(1) 1227° C (2) 927°C
(3) 327°C (4) 627°C

6. Work done by a Carnot engine operating between temperatures 127°C and 27°C is 2 kJ. The amount of heat transferred to the engine by the reservoir is:
(1) 4kJ (2) 2 kJ
(3) 8kJ (4) 2.67 kJ

7.

List-I		List II	
(A)	3 Translational degrees of freedom	(I)	Monoatomic gases
(B)	3 Translational, 2 rotational degrees of freedoms	(II)	Polyatomic gases
(C)	3 Translational, 2 rotational and 1 vibrational degrees of freedom	(III)	Rigid diatomic gases
(D)	3 Translational, 3 rotational and more than one vibrational degrees of freedom	(IV)	Nonrigid diatomic gases

Choose the correct answer from the options given below :
(1) (A) – (IV), (B) – (III), (C) – (II), (D) – (I)
(2) (A) – (IV), (B) – (II), (C) – (I), (D) – (III)
(3) (A) – (I), (B) – (III), (C) – (IV), (D) – (II)
(4) (A) – (I), (B) – (IV), (C) – (III), (D) – (II)

8. Consider two containers A and B containing monoatomic gases at the same Pressure (P), Volume (V) and Temperature (T). The gas in A is compressed isothermally to $\frac{1}{8}$ of its original volume while the gas B is compressed adiabatically to $\frac{1}{8}$ of its original volume. The ratio of final pressure of gas in B to that of gas in A is :
(1) 8 (2) $8^{\frac{3}{2}}$
(3) $\frac{1}{8}$ (4) 4

SOLUTION

9. A gas mixture consists of 2 moles of oxygen and 4 moles of neon at temperature T. Neglecting all vibrational modes, the total internal energy of the system will be :
(1) 8 RT
(2) 16 RT
(3) 4 RT
(4) 11 RT

10. A gas is compressed adiabatically, which one of the following statement is NOT true.
(1) There is no heat supplied to the system
(2) The temperature of the gas increases
(3) The change in the internal energy is equal to the work done on the gas.
(4) There is no change in the internal energy

11. 1 kg of water at 100°C is converted into steam at 100°C by boiling at atmospheric pressure. The volume of water changes from 1.00×10^{-3} m^3 as a liquid to 1.671 m^3 as steam. The change in internal energy of the system during the process will be (Given latent heat of vaporisaiton = 2257 kJ/kg. Atmospheric pressure = 1×10^5 Pa)
(1) + 2090 kJ (2) – 2090 kJ
(3) – 2426 kJ (4) + 2476 kJ

12. Three vessels of equal volume contain gases at the same temperature and pressure. The first vessel contains neon (monoatomic), the second contains chlorine (diatomic) and third contains uranium hexafloride (polyatomic). Arrange these on the basis of their root mean square speed (v_{rms}) and choose the correct answer from the options given below:
(1) $v_{rms}(\text{mono}) = v_{rms}(\text{dia}) = v_{rms}(\text{poly})$
(2) $v_{rms}(\text{mono}) > v_{rms}(\text{dia}) > v_{rms}(\text{poly})$
(3) $v_{rms}(\text{dia}) < v_{rms}(\text{poly}) < v_{rms}(\text{mono})$
(4) $v_{rms}(\text{mono}) < v_{rms}(\text{dia}) < v_{rms}(\text{poly})$

13. The thermodynamic process, in which internal energy of the system remains constant is
(1) Isochoric (2) Isothermal
(3) Adiabatic (4) Isobaric

14. The root mean square speed of molecules of nitrogen gas at 27°C is approximately:
(Given mass of a nitrogen molecule $= 4.6 \times 10^{-26}$ kg and take Boltzmann constant $k_B = 1.4 \times 10^{-23}$ JK^{-1})
(1) 523 m/s
(2) 1260 m/s
(3) 91 m/s
(4) 27.4 m/s

15. If the r.m.s. speed of chlorine molecule is 490 m/s at 27° C, the r.m.s. speed of argon molecules at the same temperature will be (Atomic mass of argon = 39.9u, molecular mass of chlorine = 70.9u)
(1) 751.7 m/s (2) 451.7 m/s
(3) 651.7 m/s (4) 551.7 m/s

16. An engine operating between the boiling and freezing points of water will have
1. efficiency more than 27%
2. efficiency less than the efficiency a Carnot engine operating between the same two temperatures.
3. efficiency equal to 27%
4. efficiency less than 27%
(1) 2, 3 and 4 only (2) 2 and 3 only
(3) 2 and 4 only (4) 1 and 2 only

SOLUTION

17. The rms speed of oxygen molecule in a vessel at particular temperature is $\left(1+\frac{5}{x}\right)^{\frac{1}{2}} \upsilon$, where υ is the average speed of the molecule. The value of x will be:(Take $\pi = \frac{22}{7}$)

(1) 28
(2) 27
(3) 8
(4) 4

18. The initial pressure and volume of an ideal gas are P_0 and V_0. The final pressure of the gas when the gas is suddenly compressed to volume $\frac{V_0}{4}$ will be : (Given γ = ratio of specific heats at constant pressure and at constant volume)

(1) $P_0(4)^{\frac{1}{\gamma}}$ (2) $P_0(4)^{\gamma}$
(3) P_0 (4) $4P_0$

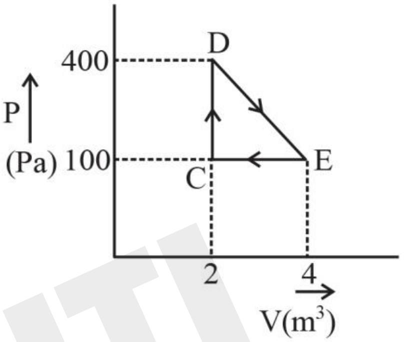
19. The mean free path of molecules of a certain gas at STP is 1500d, where d is the diameter of the gas molecules. While maintaining the standard pressure, the mean free path of the molecules at 373K is approximately :

(1) 1098d (2) 2049d
(3) 750d (4) 1500d

20. (A flask contains Hydrogen and Argon in the ratio 2:1 by mass. The temperature of the mixture is 30°C. The ratio of average kinetic energy per molecule of the two gases (K argon/K hydrogen) is: (Given: Atomic Weight of Ar = 39.9)

(1) 1 (2) 2
(3) $\frac{39.9}{2}$ (4) 39.9

21. A thermodynamic system is taken through cyclic process. The total work done in the process is :



(1) 100 J (2) 300 J
(3) Zero (4) 200 J

SOLUTION

KTG & Thermodynamics

1. 2
2. 4
3. 4
4. 4
5. 3
6. 3
7. 3
8. 4
9. 4
10. 4
11. 1
12. 2
13. 2
14. 1
15. 3
16. 3
17. 1
18. 2
19. 2
20. 1
21. 2

1. Two moles a monoatomic gas is mixed with six moles of a diatomic gas. The molar specific heat of the mixture at constant volume is :

(1) $\frac{9}{4}R$ (2) $\frac{7}{4}R$

(3) $\frac{3}{2}R$ (4) $\frac{5}{2}R$

2. The pressure and volume of an ideal gas are related as $PV^{3/2} = K$ (Constant). The work done when the gas is taken from state A (P_1, V_1, T_1) to state B (P_2, V_2, T_2) is :

(1) $2(P_1V_1 - P_2V_2)$

(2) $2(P_2V_2 - P_1V_1)$

(3) $2(\sqrt{P_1}V_1 - \sqrt{P_2}V_2)$

(4) $2(P_2\sqrt{V_2} - P_1\sqrt{V_1})$

3. A diatomic gas ($\gamma = 1.4$) does 200 J of work when it is expanded isobarically. The heat given to the gas in the process is :

(1) 850 J (2) 800 J

(3) 600 J (4) 700 J

4. If the root mean square velocity of hydrogen molecule at a given temperature and pressure is 2 km/s, the root mean square velocity of oxygen at the same condition in km/s is :

(1) 2.0 (2) 0.5

(3) 1.5 (4) 1.0

5. 0.08 kg air is heated at constant volume through 5°C. The specific heat of air at constant volume is 0.17 kcal/kg°C and J = 4.18 joule/cal. The change in its internal energy is approximately.

(1) 318 J (2) 298 J

(3) 284 J (4) 142 J

6. The average kinetic energy of a monatomic molecule is 0.414 eV at temperature :

(Use $K_B = 1.38 \times 10^{-23}$ J/mol-K)

(1) 3000 K

(2) 3200 K

(3) 1600 K

(4) 1500 K

SOLUTION - CLICK

7. The total kinetic energy of 1 mole of oxygen at 27°C is :

[Use universal gas constant (R)= 8.31 J/mole K]

(1) 6845.5 J

(2) 5942.0 J

(3) 6232.5 J

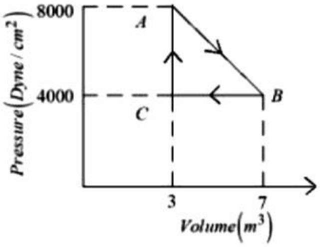
(4) 5670.5J

8. During an adiabatic process, the pressure of a gas is found to be proportional to the cube of its absolute temperature. The ratio of $\frac{C_P}{C_V}$ for the gas is :

(1) $\frac{5}{3}$ (2) $\frac{3}{2}$

(3) $\frac{7}{5}$ (4) $\frac{9}{7}$

9. A thermodynamic system is taken from an original state A to an intermediate state B by a linear process as shown in the figure. It's volume is then reduced to the original value from B to C by an isobaric process. The total work done by the gas from A to B and B to C would be :



(1) 33800 J (2) 2200 J

(3) 600 J (4) 1200 J

10. Two vessels A and B are of the same size and are at same temperature. A contains 1g of hydrogen and B contains 1g of oxygen. P_A and P_B are the pressures of the gases in A and B respectively, then $\frac{P_A}{P_B}$ is :

(1) 16 (2) 8 (3) 4 (4) 32

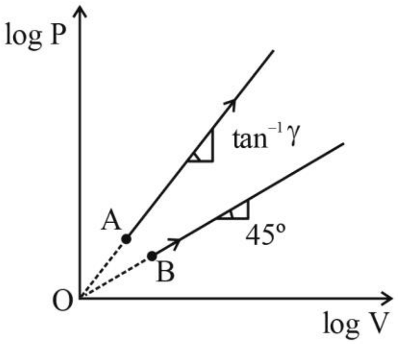
11. The temperature of a gas having 2.0×10^{25} molecules per cubic meter at 1.38 atm (Given, k = 1.38×10^{-23} JK^{-1}) is :

(1) 500 K (2) 200 K

(3) 100 K (4) 300 K

12. N moles of a polyatomic gas (f = 6) must be mixed with two moles of a monoatomic gas so that the mixture behaves as a diatomic gas. The value of N is :
(1) 6 (2) 3
(3) 4 (4) 2

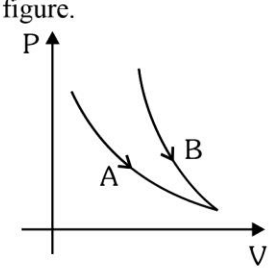
13. Two thermodynamical process are shown in the figure. The molar heat capacity for process A and B are C_A and C_B. The molar heat capacity at constant pressure and constant volume are represented by C_P and C_V, respectively. Choose the correct statement.



(1) $C_B = \infty, C_A = 0$
(2) $C_A = 0$ *and* $C_B = \infty$
(3) $C_P > C_V > C_A = C_B$
(4) $C_A > C_P > C_V$

14. At which temperature the r.m.s. velocity of a hydrogen molecule equal to that of an oxygen molecule at 47ºC?
(1) 80 K (2) –73 K
(3) 4 K (4) 20 K

15. Choose the correct statement for processes A & B shown in figure.

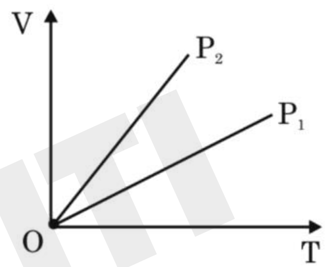


(1) $PV^{\gamma} = k$ for process B and $PV = k$ for process A.
(2) $PV = k$ for process B and A.
(3) $\dfrac{P^{\gamma-1}}{T^{\gamma}} = k$ for process B and $T = k$ for process A.
(4) $\dfrac{T^{\gamma}}{P^{\gamma-1}} = k$ for process A and $PV = k$ for process B.

16. If three moles of monoatomic gas $\left(\gamma = \frac{5}{3}\right)$ is mixed with two moles of a diatomic gas $\left(\gamma = \frac{7}{5}\right)$, the value of adiabatic exponent γ for the mixture is:
(1) 1.75 (2) 1.40
(3) 1.52 (3) 1.35

17. The parameter that remains the same for molecules of all gases at a given temperature is :
(1) kinetic energy (2) momentum
(3) mass (4) speed

18. The given figure represents two isobaric processes for the same mass of an ideal gas, then



(1) $P_2 \geq P_1$ (2) $P_2 > P_1$
(3) $P_1 = P_2$ (4) $P_1 > P_2$

19. **A** gas mixture consists of 8 moles of argon and 6 moles of oxygen at temperature T. Neglecting all vibrational modes, the total internal energy of the system is
(1) 29 RT (2) 20 RT
(3) 27 RT (4) 21 RT

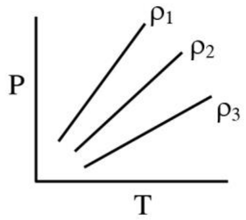
SOLUTION - CLICK

Answer Key

1. 1
2. 1
3. 4
4. 2
5. 3
6. 2
7. 3
8. 2
9. 800 (Question was Dropped)
10. 1
11. 1
12. 3
13. None is correct (Still NTA gave 1 or 2)
14. 4
15. Both 1 & 3 should be correct (NTA gave only 1)
16. 3
17. 1
18. 4
19. 3

SOLUTION - CLICK

1. P-T diagram of an ideal gas having three different densities ρ_1, ρ_2, ρ_3 (in three different cases) is shown in the figure. Which of the following is correct :



(1) $\rho_2 < \rho_3$ (2) $\rho_1 > \rho_2$

(3) $\rho_1 < \rho_2$ (4) $\rho_1 = \rho_2 = \rho_3$

2. The translational degrees of freedom (f_t) and rotational degrees of freedom (f_r) of CH_4 molecule are :

(1) $f_t = 2$ and $f_r = 2$

(2) $f_t = 3$ and $f_r = 3$

(3) $f_t = 3$ and $f_r = 2$

(4) $f_t = 2$ and $f_r = 3$

3. A sample of gas at temperature T is adiabatically expanded to double its volume. Adiabatic constant for the gas is $\gamma = 3/2$. The work done by the gas in the process is : ($\mu = 1$ mole)

(1) $RT\left[\sqrt{2}-2\right]$

(2) $RT\left[1-2\sqrt{2}\right]$

(3) $RT\left[2\sqrt{2}-1\right]$

(4) $RT\left[2-\sqrt{2}\right]$

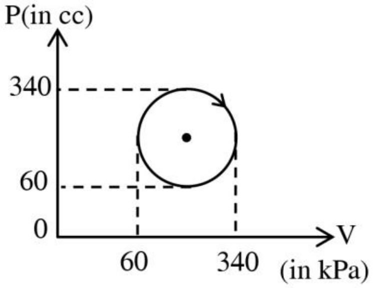
4. If the collision frequency of hydrogen molecules in a closed chamber at 27°C is Z, then the collision frequency of the same system at 127° C is :

(1) $\frac{\sqrt{3}}{2}Z$ (2) $\frac{4}{3}Z$

(3) $\frac{2}{\sqrt{3}}Z$ (4) $\frac{3}{4}Z$

SOLUTION - [CLICK]()

5. The heat absorbed by a system in going through the given cyclic process is :



(1) 61.6 J (2) 431.2 J

(3) 616 J (4) 19.6 J

6. If n is the number density and d is the diameter of the molecule, then the average distance covered by a molecule between two successive collisions (i.e. mean free path) is represented by :

(1) $\frac{1}{\sqrt{2n\pi d^2}}$ (2) $\sqrt{2}n\pi d^2$

(3) $\frac{1}{\sqrt{2}n\pi d^2}$ (4) $\frac{1}{\sqrt{2}n^2\pi^2 d^2}$

7. During an adiabatic process, if the pressure of a gas is found to be proportional to the cube of its absolute temperature, then the ratio of $\frac{C_P}{C_V}$ for the gas is :

(1) $\frac{5}{3}$ (2) $\frac{9}{7}$

(3) $\frac{3}{2}$ (4) $\frac{7}{5}$

8. The specific heat at constant pressure of a real gas obeying $PV^2 = RT$ equation is :

(1) $C_V + R$ (2) $\frac{R}{3} + C_V$

(3) R (4) $C_V + \frac{R}{2V}$

9. A sample contains mixture of helium and oxygen gas. The ratio of root mean square speed of helium and oxygen in the sample, is :

(1) $\frac{1}{32}$ (2) $\frac{2\sqrt{2}}{1}$

(3) $\frac{1}{4}$ (4) $\frac{1}{2\sqrt{2}}$

10. A total of 48 J heat is given to one mole of helium kept in a cylinder. The temperature of helium increases by 2°C. The work done by the gas is : (Given, $R = 8.3\ J\ K^{-1}mol^{-1}$.)

(1) 72.9 J (2) 24.9 J
(3) 48 J (4) 23.1 J

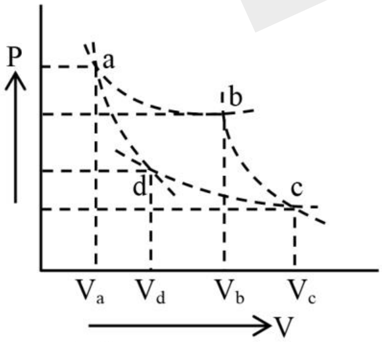
11. Energy of 10 non rigid diatomic molecules at temperature T is :

(1) $\frac{7}{2}RT$ (2) $70\ K_BT$
(3) 35 RT (4) $35\ K_BT$

12. A mixture of one mole of monoatomic gas and one mole of a diatomic gas (rigid) are kept at room temperature (27°C). The ratio of specific heat of gases at constant volume respectively is:

(1) $\frac{7}{5}$ (2) $\frac{3}{2}$
(3) $\frac{3}{5}$ (4) $\frac{5}{3}$

13. Two different adiabatic paths for the same gas intersect two isothermal curves as shown in P-V diagram. The relation between the ratio $\frac{V_a}{V_d}$ and the ratio $\frac{V_b}{V_c}$ is:



(1) $\frac{V_a}{V_d} = \left(\frac{V_b}{V_c}\right)^{-1}$ (2) $\frac{V_a}{V_d} \neq \frac{V_b}{V_c}$
(3) $\frac{V_a}{V_d} = \frac{V_b}{V_c}$ (4) $\frac{V_a}{V_d} = \left(\frac{V_b}{V_c}\right)^2$

SOLUTION - CLICK

14. **Statement (I) :** The mean free path of gas molecules is inversely proportional to square of molecular diameter.

Statement (II) : Average kinetic energy of gas molecules is directly proportional to absolute temperature of gas.

In the light of the above statements, choose the correct answer from the option given below:

(1) **Statement I** is false but **Statement II** is true.
(2) **Statement I** is true but **Statement II** is false.
(3) Both **Statement I** and **Statement II** are false
(4) Both **Statement I** and **Statement II** are true.

15. A diatomic gas ($\gamma = 1.4$) does 100 J of work in an isobaric expansion. The heat given to the gas is :

(1) 350 J (2) 490 J
(3) 150 J (4) 250 J

16. The volume of an ideal gas ($\gamma = 1.5$) is changed adiabatically from 5 litres to 4 litres. The ratio of initial pressure to final pressure is:

(1) $\frac{4}{5}$ (2) $\frac{16}{25}$
(3) $\frac{8}{5\sqrt{5}}$ (4) $\frac{2}{\sqrt{5}}$

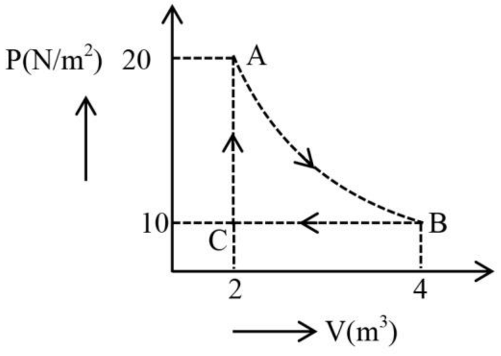
17. A sample of 1 mole gas at temperature T is adiabatically expanded to double its volume. If adiabatic constant for the gas is $\gamma = \frac{3}{2}$, then the work done by the gas in the process is:

(1) $RT\left[2-\sqrt{2}\right]$ (2) $\frac{R}{T}\left[2-\sqrt{2}\right]$
(3) $RT\left[2+\sqrt{2}\right]$ (4) $\frac{T}{R}\left[2+\sqrt{2}\right]$

18. The temperature of a gas is –78° C and the average translational kinetic energy of its molecules is K. The temperature at which the average translational kinetic energy of the molecules of the same gas becomes 2K is :

(1) –39°C (2) 117°C
(3) 127°C (4) –78°C

19. A real gas within a closed chamber at 27°C undergoes the cyclic process as shown in figure. The gas obeys $PV^3 = RT$ equation for the path A to B. The net work done in the complete cycle is (assuming $R = 8\text{J/molK}$):



(1) 225 J
(2) 205 J
(3) 20 J
(4) –20 J

SOLUTION - CLICK

Answer Key

1. 2
2. 2
3. 4
4. 3
5. 1
6. 3
7. 3
8. 4
9. 2
10. 4
11. 4
12. 3
13. 3
14. 4
15. 1
16. 3
17. 1
18. 2
19. NTA gave option 2 but its incorrect, process AB is not constant temperature process

SOLUTION - CLICK

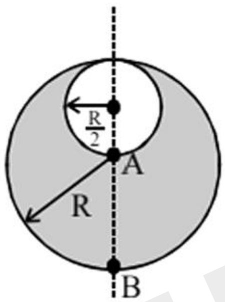
1. Hydrogen ion and singly ionized helium atom are accelerated, from rest, through the same potential difference. The ratio of final speeds of hydrogen and helium ions is close to

(a) 5 : 7 (b) 1 : 2
(c) 10 : 7 (d) 2 : 1

2. Consider two charged metallic spheres S_1 and S_2 of radii R_1 and R_2, respectively. The electric field E_1(on S_1) and E_2 (on S_2) on their surfaces are such that $E_1/E_2 = R_1/R_2$. Then the ratio V_1 (on S_1)/V_2(on S_2) of the electrostaic potentials on each sphere is

(a) $(R_1/R_2)^3$ (b) R_2/R_1
(c) R_1/R_2 (d) $(R_1/R_2)^2$

3. Consider a sphere of radius R which carries a uniform charge density ρ. If a sphere of radius $R/2$ is carved out of it, as shown, the ratio $|\vec{E}_A|/|\vec{E}_B|$ of magnitude of electric field $\vec{E}_A$ and $\vec{E}_B$, respectively, at points A and B due to the remaining portion is



(a) $\frac{21}{34}$
(b) $\frac{18}{54}$
(c) $\frac{17}{54}$
(d) $\frac{18}{34}$

4. In finding the electric field using Gauss law the formula $|\vec{E}| = \frac{q_{enc}}{\varepsilon_0 |A|}$ is applicable. In the formula ε_0 is permittivity of free space, A is the area of Gaussian surface and q_{enc} is charge enclosed by the Gaussian surface. This equation can be used in which of the following situation?

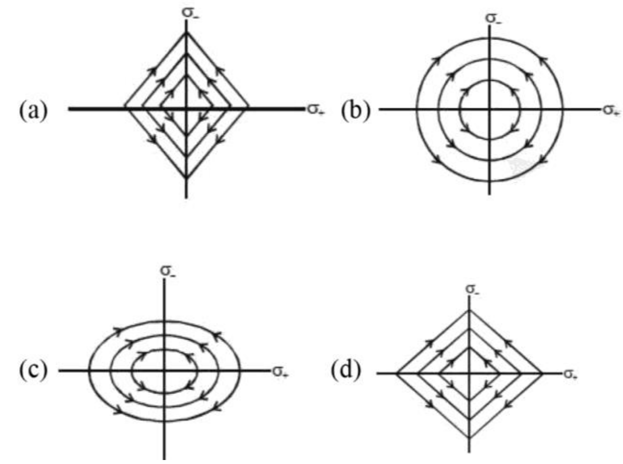
(a) For any choice of Gaussian surface.
(b) Only when the Gaussian surface is an equipotential surface.
(c) Only when the Gaussian surface is an equipotential surface and $|\vec{E}|$ is constant on the surface.
(d) Only when $|\vec{E}|$ = constant on the surface.

5. Ten charges are placed on the circumference of a circle of radius R with constant angular separation between successive charges. Alternate charges 1, 3, 5, 7, 9 have charge $(+q)$ each, while 2, 4, 6, 8, 10 have charge $(-q)$ each. The potential V and the electric field E at the centre of the circle are respectively (Take $V = 0$ at infinity)

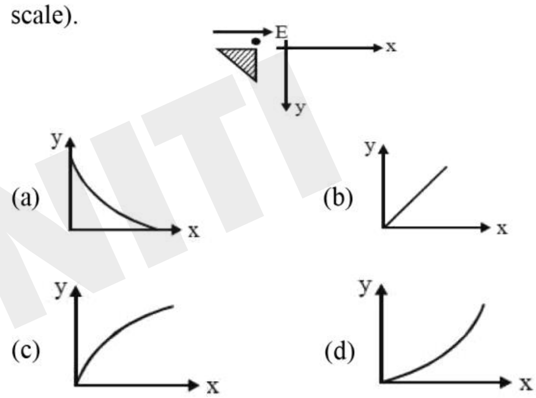
(a) $V = \frac{10q}{4\pi\varepsilon_0 R}, E = \frac{10q}{4\pi\varepsilon_0 R^2}$ (b) $V = 0, E = \frac{10q}{4\pi\varepsilon_0 R^2}$

(c) $V = 0, E = 0$ (d) $V = \frac{10q}{4\pi\varepsilon_0 R}, E = 0$

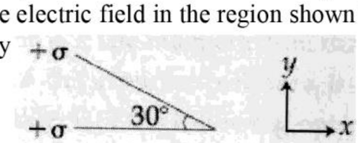
6. Two charged thin infinite plane sheets of uniform surface charge density σ_+ and σ_- where $|\sigma_+| > |\sigma_-|$ intersect at right angle. Which of the following best represents the electric field lines for this system



7. A small point mass carrying some positive charge on it, is released from the edge of a table. There is a uniform electric field in this region in the horizontal direction. Which of the following options then correctly describe the trajectory of the mass? (Curves are drawn schematically and are not to scale).



8. Two infinite planes each with uniform surface charge density $+\sigma$ are kept in such a way that the angle between them is $30°$. The electric field in the region shown between them is given by



(a) $\frac{\sigma}{\varepsilon_0}\left[\left(1+\frac{\sqrt{3}}{2}\right)\hat{y}+\frac{\hat{x}}{2}\right]$ (b) $\frac{\sigma}{2\varepsilon_0}\left[\left(1+\sqrt{3}\right)\hat{y}+\frac{\hat{x}}{2}\right]$

(c) $\frac{\sigma}{2\varepsilon_0}\left[\left(1+\sqrt{3}\right)\hat{y}-\frac{\hat{x}}{2}\right]$ (d) $\frac{\sigma}{2\varepsilon_0}\left[\left(1-\frac{\sqrt{3}}{2}\right)\hat{y}-\frac{\hat{x}}{2}\right]$

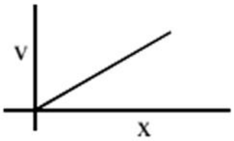
9. Three charged particles A, B and C with charges $-4q$, $2q$ and $-2q$ are present on the circumference of a circle of radius d. The charged particles A, C and centre O of the circle form an equilateral triangle as shown in figure. Electric field at O along x-direction is

(a) $\frac{\sqrt{3}q}{4\pi\varepsilon_0 d^2}$ (c) $\frac{\sqrt{3}q}{\pi\varepsilon_0 d^2}$

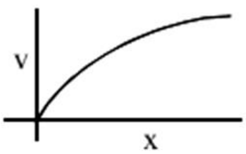
(b) $\frac{3\sqrt{3}q}{4\pi\varepsilon_0 d^2}$ (d) $\frac{2\sqrt{3}q}{\pi\varepsilon_0 d^2}$

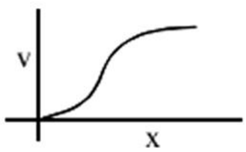
SOLUTION

10. A particle of mass m and charge q is released from rest in a uniform electric field. If there is no other force on the particle, the dependence of its speed v on the distance x travelled by it is correctly given by (graphs are schematic and not drawn to scale)

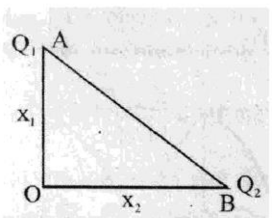
(a) 

(b) 

(c) 

(d) 

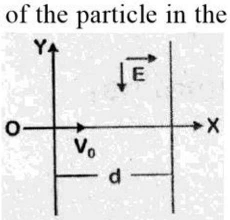
11. Charges Q_1 and Q_2 are at points A and B of a right angle triangle OAB (see figure). The resultant electric field at point O is perpendicular to the hypotenuse, then Q_1/Q_2 is proportional to



(a) $\frac{x_2^2}{x_1^2}$ (b) $\frac{x_1^3}{x_2^3}$

(c) $\frac{x_1}{x_2}$ (d) $\frac{x_2}{x_1}$

12. A charged particle (mass m and charge q) moves along X-axis with velocity V_0. When it passes through the origin it enters a region having uniform electric field $\vec{E} = -E\hat{j}$ which extends upto $x = d$. Equation of path of the particle in the region $x > d$ is

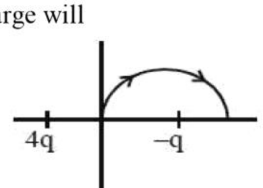


(a) $y = \frac{qEd}{mV_0^2}(x-d)$

(b) $y = \frac{qEd^2}{mV_0^2}x$

(c) $y = \frac{qEd}{mV_0^2}\left(\frac{d}{2}-x\right)$ (d) $y = \frac{qEd}{mV_0^2}x$

13. A two point charges $4q$ and $-q$ are fixed on the x-axis at $x = -d/2$ and $x = d/2$, respectively. If a third point charge 'q' is taken from the origin to $x = d$ along the semicircle as shown in the figure, the energy of the charge will



(a) increase by $\frac{2q^2}{3\pi\varepsilon_0 d}$

(b) increase by $\frac{3q^2}{4\pi\varepsilon_0 d}$

(c) decrease by $\frac{4q^2}{3\pi\varepsilon_0 d}$ (d) decrease by $\frac{q^2}{4\pi\varepsilon_0 d}$

14. Two isolated conducting spheres S_1 and S_2 of radius $2R/3$ and $R/3$ have 12 μC and −3 μC charges, respectively, and are at a large distance from each other. They are now connected by a conducting wire. A long time after this is done the charges on S_1 and S_2 are respectively

(a) 6 μC and 3 μC (b) +4.5 μC and −4.5 μC

(c) 3 μC and 6 μC (d) 4.5 μC on both

15. Consider the force F on a charge 'q' due to a uniformly charged spherical shell of radius R carrying charge Q distributed uniformly over it. Which one of the following statements is true for F, if 'q' is placed at distance r from the centre of the shell?

(a) $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ for $r > R$ (b) $\frac{1}{4\pi\varepsilon_0}\frac{qQ}{r^2} > F > 0$ for $r < R$

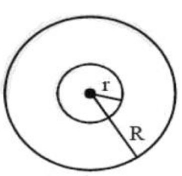
(c) $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ for all r (d) $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ for $r < R$

16. Concentric metallic hollow spheres of radii R and $4R$ hold charges Q_1 and Q_2 respectively. Given that surface charge densities of the concentric spheres are equal, the potential difference $V(R) - V(4R)$ is

(a) $\frac{3Q_1}{16\pi\varepsilon_0 R}$ (b) $\frac{Q_2}{4\pi\varepsilon_0 R}$

(c) $\frac{3Q_1}{4\pi\varepsilon_0 R}$ (d) $\frac{3Q_2}{4\pi\varepsilon_0 R}$

17. A charge Q is distributed over two concentric conducting thin spherical shells radii of r and R ($R > r$). If the surface charge densities on the two shells are equal, the electric potential at the common centre is



(a) $\frac{1}{4\pi\varepsilon_0}\frac{(R+2r)Q}{2(R^2+r^2)}$

(b) $\frac{1}{4\pi\varepsilon_0}\frac{(R+r)}{2(R^2+r^2)}Q$

(c) $\frac{1}{4\pi\varepsilon_0}\frac{(R+r)}{(R^2+r^2)}Q$

(d) $\frac{1}{4\pi\varepsilon_0}\frac{(2R+r)Q}{(R^2+r^2)}$

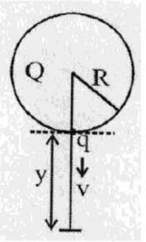
18. A particle of charge q and mass m is subjected to an electric field $E = E_0(1 - ax^2)$ in the x-direction, where a and E_0 are constants. Initially the particle was at rest at $x = 0$. Other than the initial position the kinetic energy of the particle becomes zero when the distance of the particle from the origin is

(a) $\sqrt{\frac{2}{a}}$ (b) $\sqrt{\frac{1}{a}}$

(c) a (d) $\sqrt{\frac{3}{a}}$

SOLUTION

19. A solid sphere of radius R carries a charge $(Q + q)$ distributed uniformly over its volume. A very small point like piece of it of mass m gets detached from the bottom of the sphere and falls down vertically under gravity. This piece carries charge q. If it acquires a speed v when it has fallen through a vertical height y (see figure), then : (assume the remaining portion to be spherical).



(a) $v^2 = 2y\left[\frac{qQ}{4\pi\varepsilon_0 R(R+y)m} + g\right]$

(b) $v^2 = y\left[\frac{qQ}{4\pi\varepsilon_0 R^2 ym} + g\right]$

(c) $v^2 = 2y\left[\frac{qQR}{4\pi\varepsilon_0 (R+y)^3 m} + g\right]$

(d) $v^2 = y\left[\frac{qQ}{4\pi\varepsilon_0 R(R+y)m} + g\right]$

20. An electric dipole of moment $\vec{p} = (-\hat{i} - 3\hat{j} + 2\hat{k}) \times 10^{-29}$ C.m is at the origin (0, 0, 0). The electric field due to this dipole at $\vec{r} = +\hat{i} + 3\hat{j} + 5\hat{k}$ (note that $\vec{r} \cdot \vec{p} = 0$) is parallel to

(a) $(+\hat{i} - 3\hat{j} - 2\hat{k})$ (b) $(-\hat{i} - 3\hat{j} + 2\hat{k})$

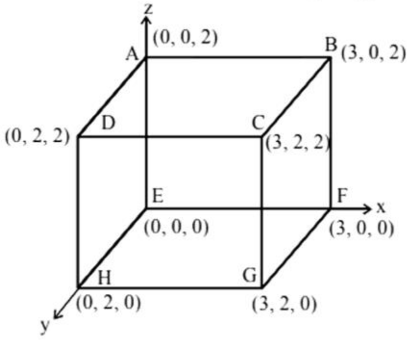
(c) $(+\hat{i} + 3\hat{j} - 2\hat{k})$ (d) $(-\hat{i} + 3\hat{j} - 2\hat{k})$

21. Two identical electric point dipoles have dipole moments $\vec{p_1} = p\hat{i}$ and $\vec{p_2} = -p\hat{i}$ and are held on the x-axis at distance 'a' from each other. When released, they move along the x-axis with the direction of their dipole moments remaining unchanged. If the mass of each dipole is 'm', their speed when they are infinitely far apart is

(a) $\frac{p}{a}\sqrt{\frac{1}{\pi\varepsilon_0 ma}}$ (b) $\frac{p}{a}\sqrt{\frac{3}{2\pi\varepsilon_0 ma}}$

(c) $\frac{p}{a}\sqrt{\frac{1}{2\pi\varepsilon_0 ma}}$ (d) $\frac{p}{a}\sqrt{\frac{2}{\pi\varepsilon_0 ma}}$

22. An electric field $\vec{E} = 4x\hat{i} - (y^2 + 1)\hat{j}$ N/C passes through the box shown in figure. The flux of the electric field through surfaces $ABCD$ and $BCGF$ are marked as ϕ_I and ϕ_{II} respectively. The difference between $(\phi_I - \phi_{II})$ is (in Nm^2/C)



SOLUTION

ANSWER KEY

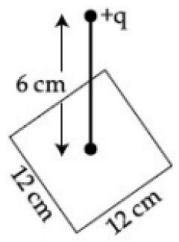
1. d
2. d
3. d
4. c
5. c
6. a
7. d
8. d
9. c
10. c
11. c
12. c
13. c
14. a
15. a
16. a
17. c
18. d
19. a
20. c
21. c
22. -48

Feb Attempt

1. Two electrons each are fixed at a distance '$2d$'. A third charge proton placed at the midpoint is displaced slightly by a distance x ($x << d$) perpendicular to the line joining the two fixed charges. Proton will execute simple harmonic motion having angular frequency : (m = mass of charged particle)

1. $\left(\frac{2q^2}{\pi\varepsilon_0 md^3}\right)^{\frac{1}{2}}$
3. $\left(\frac{q^2}{2\pi\varepsilon_0 md^3}\right)^{\frac{1}{2}}$
2. $\left(\frac{\pi\varepsilon_0 md^3}{2q^2}\right)^{\frac{1}{2}}$
4. $\left(\frac{2\pi\varepsilon_0 md^3}{q^2}\right)^{\frac{1}{2}}$

2. A point charge of $+12\ \mu C$ is at a distance 6 cm vertically above the centre of a square of side 12 cm as shown in figure. The magnitude of the electric flux through the square will be _________ $\times 10^3\ Nm^2/C$.

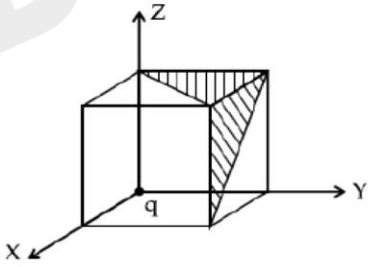


3. A cube of side 'a' has point charges $+Q$ located at each of its vertices except at the origin where the charge is $-Q$. The electric field at the centre of cube is :

1. $\frac{-2Q}{3\sqrt{3}\pi\varepsilon_0 a^2}\left(\hat{x}+\hat{y}+\hat{z}\right)$
3. $\frac{Q}{3\sqrt{3}\pi\varepsilon_0 a^2}\left(\hat{x}+\hat{y}+\hat{z}\right)$
2. $\frac{-Q}{3\sqrt{3}\pi\varepsilon_0 a^2}\left(\hat{x}+\hat{y}+\hat{z}\right)$
4. $\frac{2Q}{3\sqrt{3}\pi\varepsilon_0 a^2}\left(\hat{x}+\hat{y}+\hat{z}\right)$

4. A charge 'q' is placed at one corner of a cube as shown in figure. The flux of electrostatic field $\vec{E}$ through the shaded area is :

1. $\frac{q}{48\varepsilon_0}$
3. $\frac{q}{8\varepsilon_0}$
2. $\frac{q}{4\varepsilon_0}$
4. $\frac{q}{24\varepsilon_0}$



5. Two identical conducting spheres with negligible volume have 2.1 nC and -0.1 nC charges, respectively. They are brought into contact and then separated by a distance of 0.5 m. The electrostatic force acting between the spheres is _________ $\times 10^{-9}$ N.

[Given : $4\pi\varepsilon_0 = \frac{1}{9\times 10^9}$ SI unit]

6. Two small spheres each of mass 10 mg are suspended from a point by threads 0.5 m long. They are equally charged and repel each other to a distance of 0.20 m. The charge on each of the sphere is $\frac{a}{21}\times 10^{-8}$C. The value of 'a' will be _________.

[Given $g = 10\ ms^{-2}$]

SOLUTION

7. The electric field in a region is given by $\vec{E} = \left(\frac{3}{5}E_0\hat{i} + \frac{4}{5}E_0\hat{j}\right)\frac{N}{C}$. The ratio of flux of reported field through the rectangular surface of area 0.2 m^2 (parallel to $y-z$ plane) to that of the surface of area 0.3 m^2 (parallel to $x-z$ plane) is a : b, where a = ________ .

[Here $\hat{i}$, $\hat{j}$ and $\hat{k}$ are unit vectors along x, y and z-axes respectively]

8. 512 identical drops of mercury are charged to a potential of 2 V each. The drops are joined to form a single drop. The potential of this drop is ________ V.

9. **Statement I** : An electric dipole is placed at the centre of a hollow sphere. The flux of electric field through the sphere is zero but the electric field is not zero anywhere in the sphere.

Statement II : If R is the radius of a solid metallic sphere and Q be the total charge on it. The electric field at any point on the spherical surface of radius r (< R) is zero but the electric flux passing through this closed spherical surface of radius r is not zero.

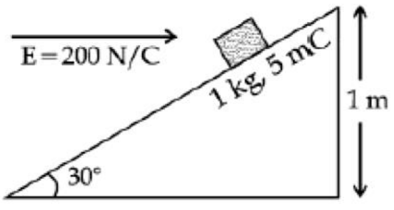
In the light of the above statements, choose the correct answer from the options given below :

1. Statement I is true but Statement II is false
2. Statement I is false but Statement II is true
3. Both Statement I and Statement II are false
4. Both Statement I and Statement II are true

10. An inclined plane making an angle of 30° with the horizontal is placed in a uniform horizontal electric field 200 $\frac{N}{C}$ as shown in the figure. A body of mass 1 kg and charge 5 mC is allowed to slide down from rest at a height of 1 m. If the coefficient of friction is 0.2, find the time taken by the body to reach the bottom.

[$g = 9.8\ m/s^2$; $\sin 30° = \frac{1}{2}$; $\cos 30° = \frac{\sqrt{3}}{2}$]

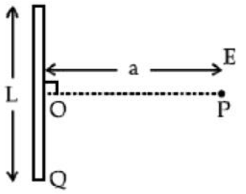
1. 1.3 s
2. 0.46 s
3. 0.92 s
4. 2.3 s



11. 27 similar drops of mercury are maintained at 10 V each. All these spherical drops combine into a single big drop. The potential energy of the bigger drop is ________ times that of a smaller drop.

12. Find the electric field at point P (as shown in figure) on the perpendicular bisector of a uniformly charged thin wire of length L carrying a charge Q. The distance of the point P from the centre of the rod is $a = \frac{\sqrt{3}}{2}L$.

1. $\frac{Q}{3\pi\varepsilon_0 L^2}$
2. $\frac{Q}{2\sqrt{3}\pi\varepsilon_0 L^2}$
3. $\frac{Q}{4\pi\varepsilon_0 L^2}$
4. $\frac{\sqrt{3}Q}{4\pi\varepsilon_0 L^2}$



SOLUTION

March Attempt

1. The electric field in a region is given by $\vec{E} = \frac{2}{5}E_0\hat{i} + \frac{3}{5}E_0\hat{j}$ with $E_0 = 4.0 \times 10^3\ \frac{N}{C}$. The flux of this field through a rectangular surface area 0.4 m^2 parallel to the Y – Z plane is _________ Nm^2C^{-1}.

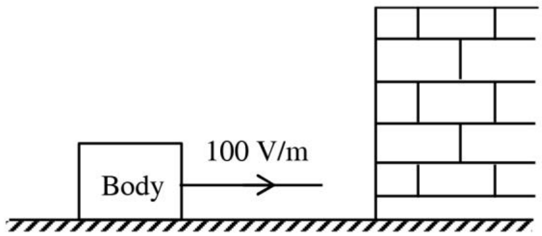
2. An oil drop of radius 2 mm with a density 3g cm^{-3} is held stationary under a constant electric field 3.55×10^5 V m^{-1} in the Millikan's oil drop experiment. What is the number of excess electrons that the oil drop will possess ? (consider g = 9.81 m/s^2)
   (1) 48.8×10^{11} (3) 17.3×10^{10}
   (2) 1.73×10^{10} (4) 1.73×10^{12}

3. An infinite number of point charges, each carrying 1 μC charge, are placed along the y-axis at y = 1 m, 2 m, 4 m, 8 m................. The total force on a 1 C point charge, placed at the origin, is $x \times 10^3$ N. The value of x, to the nearest integer, is________.
   [Take $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9\ Nm^2/C^2$]

July Attempt

1. A certain charge Q is divided into two parts q and (Q–q). How should the charges Q and q be divided so that q and (Q–q) placed at a certain distance apart experience maximum electrostatic repulsion ?
   (1) $Q = \frac{q}{2}$ (2) Q = 2q
   (3) Q = 4q (4) Q = 3q

2. A body having specific charge 8 μC/g is resting on a frictionless plane at a distance 10 cm from the wall (as shown in the figure). It starts moving towards the wall when a uniform electric field of 100 V/m is applied horizontally towards the wall. If the collision of the body with the wall is perfectly elastic, then the time period of the motion will be ______ s.



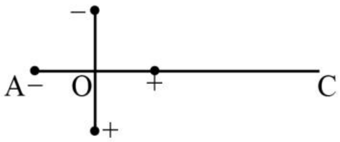
3. An electric dipole is placed on x-axis in proximity to a line charge of linear charge density 3.0×10^{-6} C/m. Line charge is placed on z-axis and positive and negative charge of dipole is at a distance of 10 mm and 12 mm from the origin respectively. If total force of 4 N is exerted on the dipole, find out the amount of positive or negative charge of the dipole.
   (1) 815.1 nC (2) 8.8 μC
   (3) 0.485 mC (4) 4.44 μC

4. The total charge enclosed in an incremental volume of 2×10^{-9} m^3 located at the origin is ______ nC, if electric flux density of its field is found as $D = e^{-x}\sin y\,\hat{i} - e^{-x}\cos y\,\hat{j} + 2z\hat{k}\ C/m^2$.

5. A particle of mass 1 mg and charge q is lying at the mid-point of two stationary particles kept at a distance '2 m' when each is carrying same charge 'q'. If the free charged particle is displaced from its equilibrium position through distance 'x' (x << 1 m). The particle executes SHM. Its angular frequency of oscillation will be _____ $\times 10^5$ rad/s if $q^2 = 10\ C^2$.

SOLUTION

6. Two ideal electric dipoles A and B, having their dipole moment p_1 and p_2 respectively are placed on a plane with their centres at O as shown in the figure. At point C on the axis of dipole A, the resultant electric field is making an angle of 37° with the axis. The ratio of the dipole moment of A and B, $\frac{p_1}{p_2}$ is : (take $\sin 37° = \frac{3}{5}$)



(1) $\frac{3}{8}$ (2) $\frac{3}{2}$ (3) $\frac{2}{3}$ (4) $\frac{4}{3}$

7. Two identical tennis balls each having mass 'm' and charge 'q' are suspended from a fixed point by threads of length 'l'. What is the equilibrium separation when each thread makes a small angle 'θ' with the vertical ?

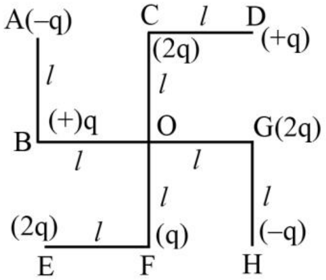
(1) $x = \left(\frac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{\frac{1}{2}}$

(2) $x = \left(\frac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{\frac{1}{3}}$

(3) $x = \left(\frac{q^2 l^2}{2\pi\varepsilon_0 m^2 g}\right)^{\frac{1}{3}}$

(4) $x = \left(\frac{q^2 l^2}{2\pi\varepsilon_0 m^2 g^2}\right)^{\frac{1}{3}}$

8. What will be the magnitude of electric field at point O as shown in figure? Each side of the figure is l and perpendicular to each other?



(1) $\frac{1}{4\pi\varepsilon_0}\frac{q}{l^2}$

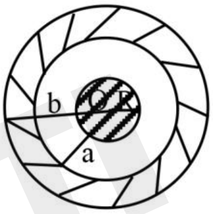
(2) $\frac{1}{4\pi\varepsilon_0}\frac{q}{(2l^2)}\left(2\sqrt{2}-1\right)$

(3) $\frac{q}{4\pi\varepsilon_0(2l)^2}$

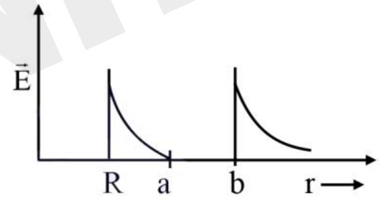
(4) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{2l^2}\left(\sqrt{2}\right)$

August Attempt

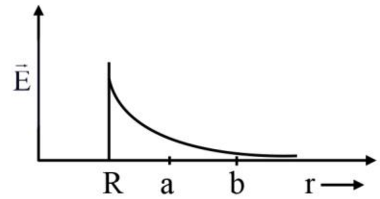
1. A solid metal sphere of radius R having charge q is enclosed inside the concentric spherical shell of inner radius a and outer radius b as shown in figure. The approximate variation electric field $\vec{E}$ as a function of distance r from centre O is given by



(1)



(2)



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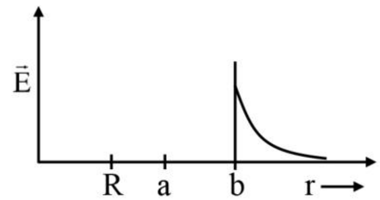
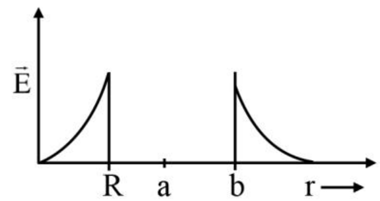


(4)



SOLUTION

2 The two thin coaxial rings, each of radius 'a' and having charges +Q and –Q respectively are separated by a distance of 's'. The potential difference between the centres of the two rings is :

(1) $\frac{Q}{2\pi\varepsilon_0}\left[\frac{1}{a}+\frac{1}{\sqrt{s^2+a^2}}\right]$ (3) $\frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{a}-\frac{1}{\sqrt{s^2+a^2}}\right]$

(2) $\frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{a}+\frac{1}{\sqrt{s^2+a^2}}\right]$ (4) $\frac{Q}{2\pi\varepsilon_0}\left[\frac{1}{a}-\frac{1}{\sqrt{s^2+a^2}}\right]$

3. A uniformly charged disc of radius R having surface charge density σ is placed in the xy plane with its center at the origin. Find the electric field intensity along the z-axis at a distance Z from origin :-

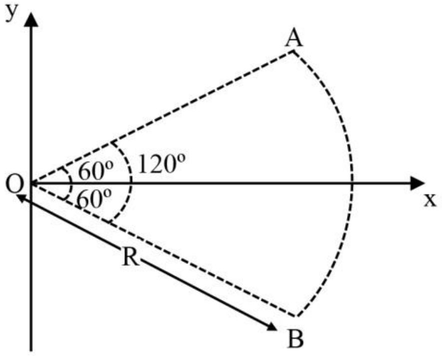
(1) $E=\frac{\sigma}{2\varepsilon_0}\left(1-\frac{Z}{(Z^2+R^2)^{1/2}}\right)$

(2) $E=\frac{\sigma}{2\varepsilon_0}\left(1+\frac{Z}{(Z^2+R^2)^{1/2}}\right)$

(3) $E=\frac{2\varepsilon_0}{\sigma}\left(\frac{1}{(Z^2+R^2)^{1/2}}+Z\right)$

(4) $E=\frac{\sigma}{2\varepsilon_0}\left(\frac{1}{(Z^2+R^2)}+\frac{1}{Z^2}\right)$

4. Figure shows a rod AB, which is bent in a 120° circular arc of radius R. A charge (–Q) is uniformly distributed over rod AB. What is the electric field $\vec{E}$ at the centre of curvature O ?

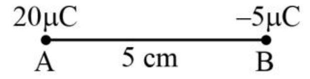


(1) $\frac{3\sqrt{3}Q}{8\pi\varepsilon_0 R^2}(\hat{i})$ (2) $\frac{3\sqrt{3}Q}{8\pi^2\varepsilon_0 R^2}(\hat{i})$

(3) $\frac{3\sqrt{3}Q}{16\pi^2\varepsilon_0 R^2}(\hat{i})$ (4) $\frac{3\sqrt{3}Q}{8\pi^2\varepsilon_0 R^2}(-\hat{i})$

SOLUTION

5. Two particles A and B having charges 20 μC and –5 μC respectively are held fixed with a separation of 5 cm. At what position a third charged particle should be placed so that it does not experience a net electric force?



(1) At 5 cm from 20 μC on the left side of system

(2) At 5 cm from – 5 μC on the right side

(3) At 1.25 cm from – 5 μC between two charges

(4) At midpoint between two charges

6. Choose the **incorrect** statement :

(a) The electric lines of force entering into a Gaussian surface provide negative flux.

(b) A charge 'q' is placed at the centre of a cube. The flux through all the faces will be the same.

(c) In a uniform electric field net flux through a closed Gaussian surface containing no net charge, is zero.

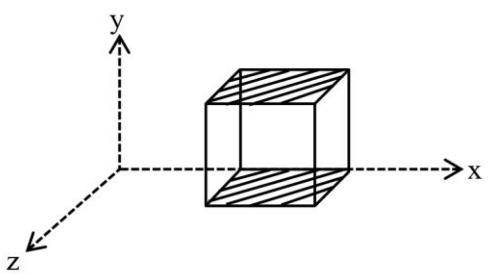
(d) When electric field is parallel to a Gaussian surface, it provides a finite non-zero flux.

Choose the most appropriate answer from the options given below

(1) (c) and (d) only (2) (b) and (d) only

(3) (d) only (4) (a) and (c) only

7. A cube is placed inside an electric field, $\vec{E}=150y^2\hat{j}$. The side of the cube is 0.5 m and is placed in the field as shown in the given figure. The charge inside the cube is :



(1) 3.8×10^{-11} C (2) 8.3×10^{-11} C

(3) 3.8×10^{-12} C (4) 8.3×10^{-12} C

ANSWER KEY

Feb Attempt

1. 3
2. 226
3. 1
4. 4
5. 36
6. 20
7. 1
8. 128
9. 1
10. 1
11. 243
12. 2

March Attempt

1. 640
2. 2
3. 12

July Attempt

1. 2
2. 1
3. 4
4. 4 *(out of syllabus)*
5. 6000
6. 3
7. 2
8. 2

August Attempt

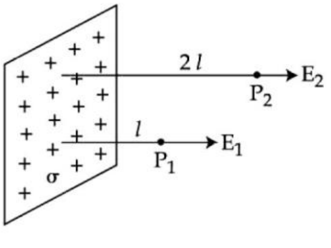
1. 1
2. 4
3. 1
4. 2
5. 2
6. 3
7. 2

1. A vertical electric field of magnitude 4.9×10^5 N/C just prevents a water droplet of a mass 0.1 g from falling. The value of charge on the droplet will be :
(Given $g = 9.8$ m/s^2)
(A) 1.6×10^{-9} C (B) 2.0×10^{-9} C
(C) 3.2×10^{-9} C (D) 0.5×10^{-9} C

2. Two identical charged particles each having a mass 10 g and charge 2.0×10^{-7} C area placed on a horizontal table with a separation of L between then such that they stay in limited equilibrium. If the coefficient of friction between each particle and the table is 0.25, find the value of L. [Use $g = 10$ ms^{-2}]
(A) 12 cm (B) 10 cm
(C) 8 cm (D) 5 cm

3. A long cylindrical volume contains a uniformly distributed charge of density ρ. The radius of cylindrical volume is R. A charge particle (q) revolves around the cylinder in a circular path. The kinetic of the particle is :
(A) $\frac{\rho q R^2}{4\varepsilon_0}$ (B) $\frac{\rho q R^2}{2\varepsilon_0}$
(C) $\frac{q\rho}{4\varepsilon_0 R^2}$ (D) $\frac{4\varepsilon_0 R^2}{q\rho}$

4. In the figure, a very large plane sheet of positive charge is shown. P_1 and P_2 are two points at distance l and $2l$ from the charge distribution. If σ is the surface charge density, then the magnitude of electric fields E_1 and E_2 at P_1 and P_2 respectively are :



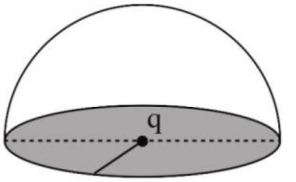
(A) $E_1 = \sigma/\varepsilon_0, E_2 = \sigma/2\varepsilon_0$
(B) $E_1 = 2\sigma/\varepsilon_0, E_2 = \sigma/\varepsilon_0$
(C) $E_1 = E_2 = \sigma/2\varepsilon_0$
(D) $E_1 = E_2 = \sigma/\varepsilon_0$

5. 27 identical drops are charged at 22V each. They combine to form a bigger drop. The potential of the bigger drop will be ____ V.

6. **Assertion (A) :** Non-polar material do not have any permanent dipole moment.
Reason (R) : When an non-polar material is placed in a electric field the centre of the positive charge distribution of it's individual atom or molecule coinsides with the centre of the negative charge distribution.
In the light of above statements, choose the most appropriate answer from the options given below.
(A) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(B) Both (A) and (R) are correct and (R) is not the correct explanation of (A).
(C) (A) is correct but (R) is not correct.
(D) (A) is not correct but (R) is correct.

7. Sixty four conducting drops each of radius 0.02 m and each carrying a charge of 5 μC are combined to form a bigger drop. The ratio of surface density of bigger drop to the smaller drop will be :
(A) 1 : 4 (B) 4 : 1 (C) 1 : 8 (D) 8 : 1

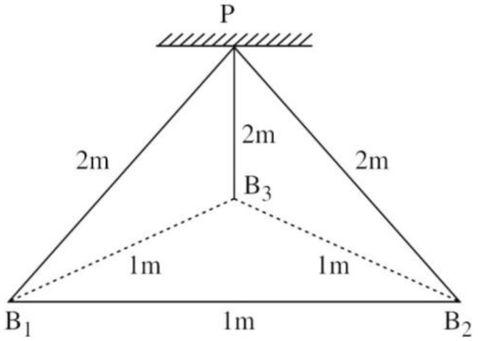
8. If a charge q is placed at the centre of a closed hemispherical non-conducting surface, the total flux passing through the flat surface would be :



(A) $\frac{q}{\varepsilon_0}$ (B) $\frac{q}{2\varepsilon_0}$
(C) $\frac{q}{4\varepsilon_0}$ (D) $\frac{q}{2\pi\varepsilon_0}$

SOLUTION

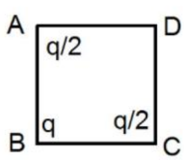
9. Three identical charged balls each of charge 2C are suspended from a common point P by silk threads of 2m each (as shown in figure). They form an equilateral triangle of side 1m.
The ratio of net force on a charged ball to the force between any two charged balls will be :



(A) 1 : 1 (B) 1 : 4
(C) $\sqrt{3}:2$ (D) $\sqrt{3}:1$

10. **Statement-I :** A point charge is brought in an electric field. The value of electric field at a point near to the charge may increase if the charge is positive.
Statement-II : An electric dipole is placed in a non-uniform electric field. The net electric force on the dipole will not be zero.
Choose the correct answer from the options given below :
(A) Both statement-I and statement-II are true.
(B) Both statement-I and statement-I are false.
(C) Statement-I is true but statement-II is false.
(D) Statement-I is false but statement-II is true.

11. The three charges q/2, q and q/2 are placed at the corners A, B and C of a square of side 'a' as shown in figure. The magnitude of electric field (E) at the corner D of the square, is :



(A) $\frac{q}{4\pi\epsilon_0 a^2}\left(\frac{1}{\sqrt{2}}+\frac{1}{2}\right)$ (C) $\frac{q}{4\pi\epsilon_0 a^2}\left(1-\frac{1}{\sqrt{2}}\right)$

(B) $\frac{q}{4\pi\epsilon_0 a^2}\left(1+\frac{1}{\sqrt{2}}\right)$ (D) $\frac{q}{4\pi\epsilon_0 a^2}\left(\frac{1}{\sqrt{2}}-\frac{1}{2}\right)$

12. Two point charges A and B of magnitude $+8\times10^{-6}$C and -8×10^{-6}C respectively are placed at a distance d apart. The electric field at the middle point O between the charges is $6.4\times10^{4}\,NC^{-1}$. The distance 'd' between the point charges A and B is:
(A) 2.0 m (B) 3.0 m
(C) 1.0 m (D) 4.0 m

13. A positive charge particle of 100 mg is thrown in opposite direction to a uniform electric field of strength $1\times10^{5}\,NC^{-1}$. If the charge on the particle is 40 μC and the initial velocity is 200 ms^{-1}, how much distance it will travel before coming to the rest momentarily :
(A) 1 m (B) 5 m
(C) 10 m (D) 0.5 m

14. Two point charges Q each are placed at a distance d apart. A third point charge q is placed at a distance x from mid-point on the perpendicular bisector. The value of x at which charge q will experience the maximum Coulomb's force is :
(A) x = d (B) $x=\frac{d}{2}$
(C) $x=\frac{d}{\sqrt{2}}$ (D) $x=\frac{d}{2\sqrt{2}}$

15. If the electric potential at any point (x, y, z)m in space is given by $V = 3x^2$ volt. The electric field at the point (1, 0, 3) m will be :
(A) 3 Vm^{-1}, directed along positive x-axis.
(B) 3 Vm^{-1}, directed along negative x-axis.
(C) 6 Vm^{-1}, directed along positive x-axis.
(D) 6 Vm^{-1}, directed along negative x-axis.

SOLUTION

Electrostatics

1. B
2. A
3. A
4. C
5. 198
6. C
7. B
8. B
9. D
10. A
11. A
12. B
13. D
14. D
15. D

1. The volume charge density of a sphere of radius 6 m is 2 $\mu C\ cm^{-3}$. The number of lines of force per unit surface area coming out from the surface of the sphere is ______ $\times 10^{10}\ NC^{-1}$.

[Given : Permittivity of vacuum $\epsilon_0 = 8.85 \times 10^{-12}\ C^2\ N^{-1} - m^{-2}$]

2. Two uniformly charged spherical conductors A and B of radii 5 mm and 10 mm are separated by a distance of 2 cm. If the spheres are connected by a conducting wire, then in equilibrium condition, the ratio of the magnitudes of the electric fields at the surface of the sphere A and B will be :
(A) 1 : 2 (B) 2 : 1 (C) 1 : 1 (D) 1 : 4

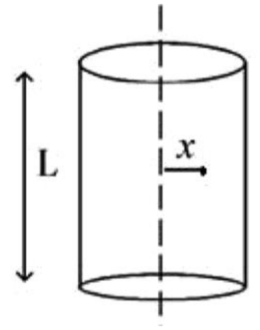
3. Three point charges of magnitude $5\mu C$, $0.16\mu C$ and $0.3\mu C$ are located at the vertices A, B, C of a right angled triangle whose sides are AB = 3cm, $BC = 3\sqrt{2}$ cm and CA=3 cm and point A is the right angle corner. Charge at point A experiences _______ N of electrostatic force due to the other two charges.

4. Two identical positive charges Q each are fixed at a distance of '2a' apart from each other. Another point charge q_0 with mass 'm' is placed at midpoint between two fixed charges. For a small displacement along the line joining the fixed charges, the charge q_0 executes SHM. The time period of oscillation of charge q_0 will be :

(A) $\sqrt{\frac{4\pi^3\varepsilon_0 ma^3}{q_0 Q}}$ (B) $\sqrt{\frac{q_0 Q}{4\pi^3\varepsilon_0 ma^3}}$

(C) $\sqrt{\frac{2\pi^2\varepsilon_0 ma^3}{q_0 Q}}$ (D) $\sqrt{\frac{8\pi^3\varepsilon_0 ma^3}{q_0 Q}}$

5. A long cylindrical volume contains a uniformly distributed charge of density $\rho\ Cm^{-3}$. The electric field inside the cylindrical volume at a distance $x = \frac{2\varepsilon_0}{\rho}$ m from its axis is ______ Vm^{-1}



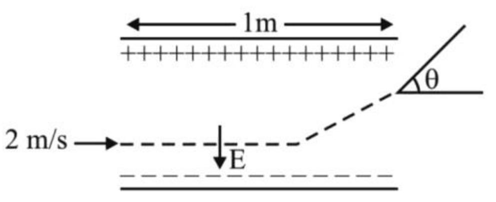
SOLUTION

6. A charge of 4 μC is to be divided into two. The distance between the two divided charges is constant. The magnitude of the divided charges so that the force between them is maximum, will be:

(A) 1 μC and 3 μC (B) 2 μC and 2 μC
(C) 0 and 4 μC (D) 1.5 μC and 2.5 μC

7. Two electric dipoles of dipole moments 1.2×10^{-30} cm and 2.4×10^{-30} cm are placed in two difference uniform electric fields of strengths $5 \times 10^4\ NC^{-1}$ and $15 \times 10^4\ NC^{-1}$ respectively. The ratio of maximum torque experienced by the electric dipoles will be $\frac{1}{x}$. The value of x is _______.

8. A uniform electric field E = (8m/e) V/m is created between two parallel plates of length 1m as shown in figure, (where m = mass of electron and e = charge of electron). An electron enters the field symmetrically between the plates with a speed of 2m/s. The angle of the deviation (θ) of the path of the electron as it comes out of the field will be ……….



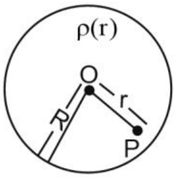
(A) $\tan^{-1}(4)$ (B) $\tan^{-1}(2)$

(C) $\tan^{-1}\left(\frac{1}{3}\right)$ (D) $\tan^{-1}(3)$

9. A spherically symmetric charge distribution is considered with charge density varying as

$$\rho(r) = \begin{cases} \rho_0\left(\frac{3}{4} - \frac{r}{R}\right) & \text{for } r \le R \\ \text{Zero} & \text{for } r > R \end{cases}$$

Where, r(r < R) is the distance from the centre O (as shown in figure). The electric field at point P will be :



(A) $\frac{\rho_0 r}{4\varepsilon_0}\left(\frac{3}{4} - \frac{r}{R}\right)$ (B) $\frac{\rho_0 r}{3\varepsilon_0}\left(\frac{3}{4} - \frac{r}{R}\right)$

(C) $\frac{\rho_0 r}{4\varepsilon_0}\left(1 - \frac{r}{R}\right)$ (D) $\frac{\rho_0 r}{5\varepsilon_0}\left(1 - \frac{r}{R}\right)$

10. **Statement I :** Electric potential is constant within and at the surface of each conductor.

Statement II : Electric field just outside a charged conductor is perpendicular to the surface of the conductor at every point.

In the light of the above statements, choose the most appropriate answer from the options give below.

(A) Both statement I and statement II are correct
(B) Both statement I and statement II are incorrect
(C) Statement I is correct but statement II is incorrect
(D) Statement I is incorrect but and statement II is correct

11. Two identical metallic spheres A and B when placed at certain distance in air repel each other with a force of F. Another identical uncharged sphere C is first placed in contact with A and then in contact with B and finally placed at midpoint between spheres A and B. The force experienced by sphere C will be :

(A) 3F/2 (B) 3F/4
(C) F (D) 2F

12. An α particle and a proton are accelerated from rest through the same potential difference. The ratio of linear momenta acquired by above two particals will be :

(A) $\sqrt{2} : 1$ (B) $2\sqrt{2} : 1$

(C) $4\sqrt{2} : 1$ (D) $8 : 1$

SOLUTION

ANSWER KEY

1. 45
2. B
3. 17
4. A
5. 1
6. B
7. 6
8. B
9. C
10. A
11. B
12. B

1. Two equal positive point charges are separated by a distance $2a$. The distance of a point from the centre of the line joining two charges on the equatorial line (perpendicular bisector) at which force experienced by a test charge q_0 becomes maximum is $\frac{a}{\sqrt{x}}$. The value of x is __________.

2. A cubical volume is bounded by the surfaces $x = 0, x = a, y = 0, y = a, z = 0, z = a$. The electric field in the region is given by $\vec{E} = E_0 x \hat{i}$. Where $E_0 = 4 \times 10^4\ NC^{-1}\ m^{-1}$. If $a = 2$ cm, the charge contained in the cubical volume is $Q \times 10^{-14}$C. The value of Q is____.

Take $\epsilon_0 = 9 \times 10^{-12}\ C^2/Nm^2$)

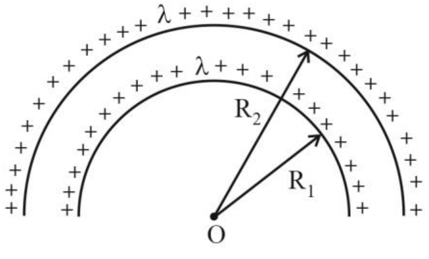
3. If two charges q_1 and q_2 are separated with distance 'd' and placed in a medium of dielectric constant K. What will be the equivalent distance between charges in air for the same electrostatic force ?

(1) $d\sqrt{k}$ (2) $k\sqrt{d}$

(3) $1.5d\sqrt{k}$ (4) $2d\sqrt{k}$

4. A stream of a positively charged particles having $\frac{q}{m} = 2 \times 10^{11} \frac{C}{kg}$ and velocity $\vec{v}_0 = 3 \times 10^7\ \hat{i}\ m/s$ is deflected by an electric field $1.8\hat{j}$kV/m. The electric field exists in a region of 10 cm along x direction. Due to the electric field, the deflection of the charge particles in the y direction is _____ mm.

5. The electric potential at the centre of two concentric half rings of radii R_1 and R_2, having same linear charge density λ is

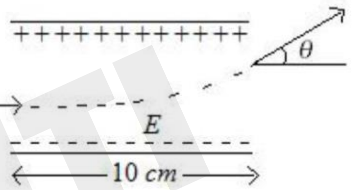


SOLUTION

(1) $\frac{2\lambda}{\epsilon_0}$ (2) $\frac{\lambda}{2\epsilon_0}$

(3) $\frac{\lambda}{4\epsilon_0}$ (4) $\frac{\lambda}{\epsilon_0}$

6. A uniform electric field of 10 N/C is created between two parallel charged plates (as shown in figure). An electron enters the field symmetrically between the plates with a kinetic energy 0.5 eV. The length of each plate is 10 cm. The angle (θ) of deviation of the path of electron as it comes out of the field is ___ (in degree).



7. A point charge of 10 μC is placed at the origin. At what location on the X-axis should a point charge of 40μC be placed so that the net electric field is zero at x = 2 cm on the X-axis ?

(1) x = 6 cm (2) x = 4 cm

(3) x = 8 cm (4) x = –4 cm

8. In a cuboid of dimension $2L \times 2L \times L$, a charge q is placed at the centre of the surface 'S' having area of 4 L^2. The flux through the opposite surface to 'S' is given by

(1) $\frac{q}{12\varepsilon_0}$ (2) $\frac{q}{3\varepsilon_0}$

(3) $\frac{q}{2\varepsilon_0}$ (4) $\frac{q}{6\varepsilon_0}$

9. A point charge $q_1 = 4q_0$ is placed at origin. Another point charge $q_2 = -q_0$ is placed at x = 12 cm. Charge of proton is q_0. The proton is placed on x-axis so that the electrostatic force on the proton in zero. In this situation, the position of the proton from the origin is _____ cm.

10. A point charge 2×10^{-2} C is moved from P to S in a uniform electric field of 30 NC^{-1} directed along positive x-axis. If coordinates of P and S are (1, 2, 0) m and (0, 0, 0) m respectively, the work done by electric field will be

(1) 1200 mJ (2) 600 mJ

(3) –600 mJ (4) –1200 mJ

11. For a charged spherical ball, electrostatic potential inside the ball varies with r as $V = 2ar^2 + b$.

Here, a and b are constant and r is the distance from the center. The volume charge density inside the ball is $-\lambda a\varepsilon$. The value of λ is ________.

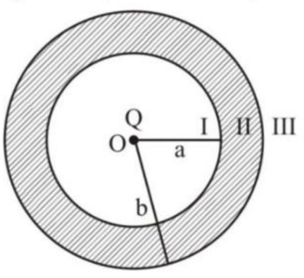
ε = permittivity of medium.

12. Two isolated metallic solid spheres of radii R and 2R are charged such that both have same charge density σ. The spheres are then connected by a thin conducting wire. If the new charge density of the bigger sphere is σ'. The ratio $\frac{\sigma'}{\sigma}$ is :

(1) $\frac{9}{4}$ (2) $\frac{4}{3}$

(3) $\frac{5}{3}$ (4) $\frac{5}{6}$

13. As shown in the figure, a point charge Q is placed at the centre of conducting spherical shell of inner radius a and outer radius b. The electric field due to charge Q in three different regions I, II and III is given by : (I : r < a, II : a < r < b, III : r > b)



(1) $E_I = 0, E_{II} = 0, E_{III} \neq 0$

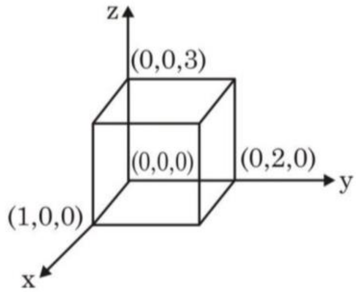
(2) $E_I \neq 0, E_{II} = 0, E_{III} \neq 0$

(3) $E_I \neq 0, E_{II} = 0, E_{III} = 0$

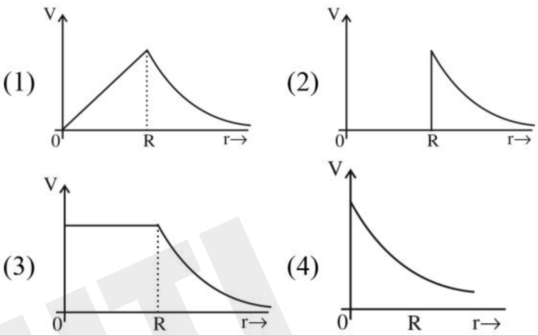
(4) $E_I = 0, E_{II} = 0, E_{III} = 0$

14. As shown in figure, a cuboid lies in a region with electric field $E = 2x^2\hat{i} - 4y\hat{j} + 6\hat{k}$ N/C. The magnitude of charge within the cuboid is $n\epsilon_0$ C. The value of n is _______ (if dimension of cuboid is $1 \times 2 \times 3$ m^3)

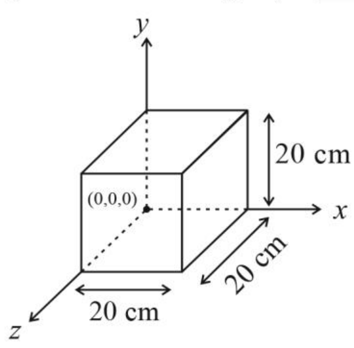
SOLUTION



15. Which of the following correctly represents the variation of electric potential (V) of a charged spherical conductor of radius (R) with radial distance (r) from the centre?



16. Expression for an electric field is given by $\vec{E} = 4000\,x^2\hat{i}\,\frac{V}{m}$. The electric flux through the cube of side 20 cm when placed in electric field (as shown in the figure) is _______ V cm.



17. Considering a group of positive charges, which of the following statements is correct?

(1) Net potential of the system cannot be zero at a point but net electric field can be zero at that point.

(2) Net potential of the system at a point can be zero but net electric field can't be zero at that point.

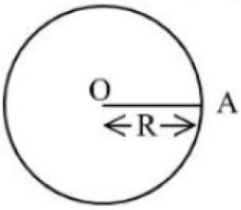
(3) Both the net potential and the net field can be zero at a point.

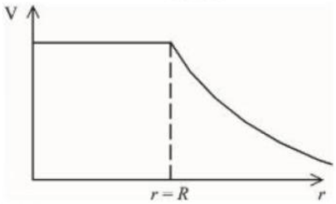
(4) Both the net potential and the net electric field cannot be zero at a point.

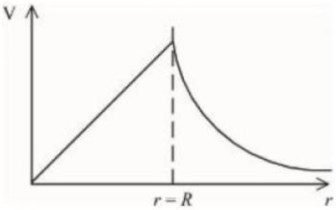
ELECTROSTATICS

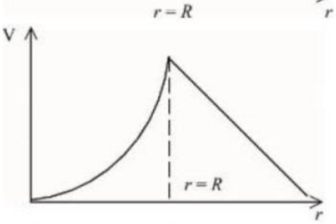
1. 2
2. 288
3. 1
4. 2
5. 2
6. 450
7. 1
8. 4
9. 24
10. 3
11. 12
12. 4
13. 2
14. 12
15. 3
16. 640
17. 1

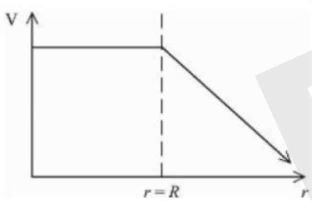
1. For a uniformly charged thin spherical shell, the electric potential (V) radially away from the center (O) of shell can be graphically represented as



(1) 

(2) 

(3) 

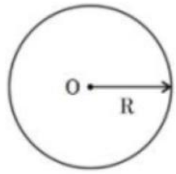
(4) 

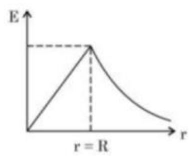
2. A dipole comprises of two charged particles of identical magnitude q and opposite in nature. The mass 'm' of the positive charged particle is half of the mass of the negative charged particle. The two charges are separated by a distance 'l'. If the dipole is placed in a uniform electric field '$\vec{E}$'; in such a way that dipole axis makes a very small angle with the electric field, '$\vec{E}$' The angular frequency of the oscillations of the dipole when released is given by:

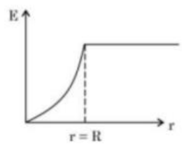
(1) $\sqrt{\frac{8qE}{3ml}}$ (2) $\sqrt{\frac{4qE}{ml}}$

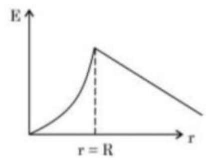
(3) $\sqrt{\frac{4qE}{3ml}}$ (4) $\sqrt{\frac{8qE}{ml}}$

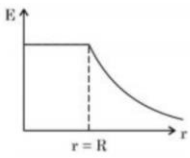
3. Graphical variation of electric field due to a uniformly charged insulating solid sphere of radius R, with distance r from the centre O is represented by:



(1) 

(2) 

(3) 

(4) 

4. An electric dipole of dipole moment is 6.0×10^{-6} Cm placed in a uniform electric field of $1.5\times10^{3}\,NC^{-1}$ in such a way that dipole moment is along electric field. The work done in rotating dipole by 180° in this field will be _____mJ

5. Electric potential at a point 'P' due to a point charge of 5×10^{-9} C is 50 V. The distance of 'P' from the point charge is:

(Assume, $\frac{1}{4\pi\varepsilon_0}=9\times10^{+9}\,Nm^2C^{-2}$)

(1) 3 cm (2) 9 cm

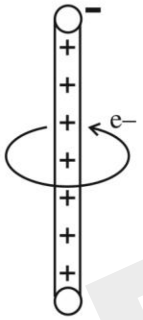
(3) 90 cm (4) 0.9 cm

6. Three concentric spherical metallic shells X, Y and Z of radius a, b and c respectively $[a<b<c]$ have surface charge densities $\sigma, -\sigma$ and σ, respectively. The shells X and Z are at same potential. If the radii of X & Y are 2 cm and 3 cm, respectively. The radius of shell Z is ___________ cm.

SOLUTION

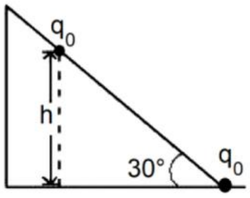
7. In a metallic conductor, under the effect of applied electric field, the free electrons of the conductor
(1) drift from higher potential to lower potential.
(2) move in the curved paths from lower potential to higher potential
(3) move with the uniform velocity throughout from lower potential to higher potential
(4) move in the straight line paths in the same direction

8. An electron revolves around an infinite cylindrical wire having uniform linear change density 2×10^{-8} Cm^{-1} in circular path under the influence of attractive electrostatic field as shown in the figure. The velocity of electron with which it is revolving is_____ $\times$ 10^{6} ms^{-1}. Given mass of electron = 9×10^{-31} kg.



9. As shown in the figure. a configuration of two equal point charges (q_0 = +2μ C) is placed on an inclined plane. Mass of each point charge is 20 g. Assume that there is no friction between charge and plane. For the system of two point charges to be in equilibrium (at rest) the height h = x $\times$ 10^{-3} m The value of x is ____.

(Take $\frac{1}{4\pi\varepsilon_0} = 9\times10^9 \text{N m}^2\text{C}^{-2}, g = 10 \text{ ms}^{-1}$)



10. **Assertion A :** If an electric dipole of dipole moment 30×10^{-5} Cm is enclosed by a closed surface, the net flux coming out of the surface will be zero.
Reason R : Electric dipole consists of two equal and opposite charges.
In the light of above, statements, choose the correct answer from the options given below:
(1) Both A and R are true and R is the correct explanation of A
(2) A is true but R is false
(3) Both A and R true but R is NOT the correct explanation of A
(4) A is false but R is true

11. 64 identical drops each charged upto potential of 10 mV are combined to form a bigger dorp. The potential of the bigger drop will be ______ mV.

12. Two charges each of magnitude 0.01 C and separated by a distance of 0.4 mm constitute an electric dipole. If the dipole is placed in an uniform electric field '$\vec{E}$' of 10 dyne/C making 30^0 angle with $\vec{E}$, the magnitude of torque acting on dipole is :
(1) 4.0×10^{-10} Nm (2) 2.0×10^{-10} Nm
(3) 1.0×10^{-8} Nm (4) 1.5×10^{-9} Nm

13. A thin infinite sheet charge and an infinite line charge of respective charge densities $+\sigma$ and $+\lambda$ are placed parallel at 5 m distance from each other. Points 'P' and 'Q' are at $\frac{3}{\pi}$ m and $\frac{4}{\pi}$ m perpendicular distance from line charge towards sheet charge, respectively. 'E_P' and 'E_Q' are the magnitudes of resultant electric field intensities at point 'P' and 'Q', respectively. If $\frac{E_P}{E_Q} = \frac{4}{a}$ for $2|\sigma| = |\lambda|$. Then the value of a is ____________.

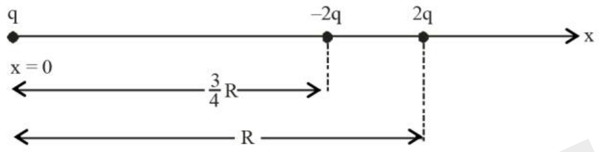
SOLUTION

14. A 10 μC charge is divided into two parts and placed at 1 cm distance so that the repulsive force between them is maximum. The charges of the two parts are :

(1) 9 μC, 1 μC (2) 5 μC, 5 μC

(3) 7 μC, 3 μC (4) 8 μC, 2 μC

15. Three point charges q, –2q and 2q are placed on x-axis at a distance $x = 0$, $x = \frac{3}{4}R$ and $x = R$ respectively from origin as shown. If $q = 2 \times 10^{-6}$ C and R = 2 cm, the magnitude of net force experienced by the charge –2q is _________ N.



16. The electric field due to a short electric dipole at a large distance (r) from center of dipole on the equatorial plane varies with distance as :

(1) r (2) $\frac{1}{r}$

(3) $\frac{1}{r^3}$ (4) $\frac{1}{r^2}$

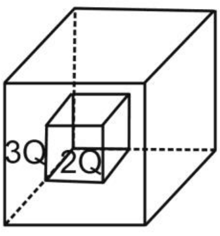
SOLUTION

Electrostatics

1. 1
2. 3 (Although if we assume it to rotate about COM then answer would be different)
3. 1
4. 18
5. 3
6. 5
7. 2
8. 8
9. 300
10. 1
11. 160
12. 2
13. 6
14. 2
15. 5440
16. 3

1. Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle θ with each other. When suspended in water the angle remains the same. If density of the material of the sphere is 1.5 g/cc, the dielectric constant of water will be ________ (Take density of water = 1 g/cc)

2. C_1 and C_2 are two hollow concentric cubes enclosing charges 2Q and 3Q respectively as shown in figure. The ratio of electric flux passing through C_1 and C_2 is :



(1) 2 : 5 (2) 5 : 2
(3) 2 : 3 (4) 3 : 2

3 Suppose a uniformly charged wall provides a uniform electric field of 2×10^4 N/C normally. A charged particle of mass 2 g being suspended through a silk thread of length 20 cm and remain stayed at a distance of 10 cm from the wall. Then the charge on the particle will be $\frac{1}{\sqrt{x}}\mu C$ where x =______. [use $g = 10\ m/s^2$]

4. An electric charge $10^{-6}\mu C$ is placed at origin (0, 0) m of X –Y co-ordinate system. Two points P and Q are situated at $(\sqrt{3},\sqrt{3})$m and $(\sqrt{6},0)$m respectively. The potential difference between the points P and Q will be :
(1) $\sqrt{3}$V
(2) $\sqrt{6}$V
(3) 0 V
(4) 3 V

SOLUTION - CLICK

5. A thin metallic wire having cross sectional area of $10^{-4}\ m^2$ is used to make a ring of radius 30 cm. A positive charge of 2π C is uniformly distributed over the ring, while another positive charge of 30 pC is kept at the centre of the ring. The tension in the ring is ______ N ; provided that the ring does not get deformed (neglect the influence of gravity). (given, $\frac{1}{4\pi\epsilon_0} = 9\times10^9$ SI units)

6. **Assertion (A) :** Work done by electric field on moving a positive charge on an equipotential surface is always zero.
Reason (R) : Electric lines of forces are always perpendicular to equipotential surfaces.
In the light of the above statements, choose the most appropriate answer from the options given below :
(1) Both (A) and (R) are correct but (R) is not the correct explanation of (A)
(2) ((A) is correct but (R) is not correct
(3) (A) is not correct but (R) is correct
(4) Both (A) and (R) are correct and (R) is the correct explanation of (A)

7. Two charges of –4 μC and +4 μC are placed at the points A(1, 0, 4)m and B(2, –1, 5) m located in an electric field $\vec{E} = 0.20\ \hat{i}\ V/cm$. The magnitude of the torque acting on the dipole is $8\sqrt{\alpha}\times10^{-5}$ Nm, Where α = _____.

8. The electric potential at the surface of an atomic nucleus (z = 50) of radius 9×10^{-13} cm is ________ $\times 10^{6}$ V.

9. Two charges of 5Q and –2Q are situated at the points (3a, 0) and (–5a, 0) respectively. The electric flux through a sphere of radius '4a' having center at origin is :
(1) $\frac{2Q}{\varepsilon_0}$ (2) $\frac{5Q}{\varepsilon_0}$
(3) $\frac{7Q}{\varepsilon_0}$ (4) $\frac{3Q}{\varepsilon_0}$

10. An electron is moving under the influence of the electric field of a uniformly charged infinite plane sheet S having surface charge density $+\sigma$. The electron at $t = 0$ is at a distance of 1 m from S and has a speed of 1 m/s. The maximum value of σ if the electron strikes S at $t = 1$ s is $\alpha\left[\frac{m\epsilon_0}{e}\right]\frac{C}{m^2}$ the value of α is

11. An electric field is given by $(6\hat{i}+5\hat{j}+3\hat{k})$ N/C. The electric flux through a surface area $30\hat{i}\,m^2$ lying in YZ-plane (in SI unit) is :
(1) 90 (2) 150 (3) 180 (4) 60

12. The electrostatic potential due to an electric dipole at a distance 'r' varies as :
(1) r
(2) $\frac{1}{r^2}$
(3) $\frac{1}{r^3}$
(4) $\frac{1}{r}$

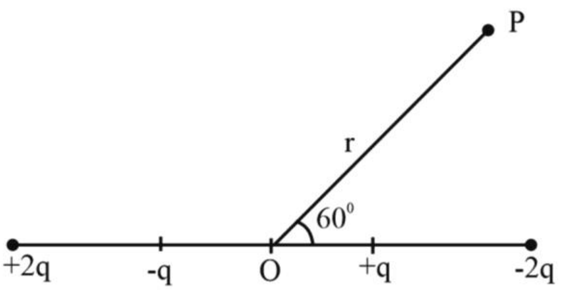
13. A particle of charge '–q' and mass 'm' moves in a circle of radius 'r' around an infinitely long line charge of linear density '$+\lambda$'. Then time period will be given as:
(Consider k as Coulomb's constant)
(1) $T^2 = \frac{4\pi^2 m}{2k\lambda q} r^3$
(2) $T = 2\pi r\sqrt{\frac{m}{2k\lambda q}}$
(3) $T = \frac{1}{2\pi r}\sqrt{\frac{m}{2k\lambda q}}$
(4) $T = \frac{1}{2\pi}\sqrt{\frac{2k\lambda q}{m}}$

14. Two identical charged spheres are suspended by string of equal lengths. The string make an angle of 37° with each other. When suspended in a liquid of density 0.7 g/cm^3, the angle remains same. If density of material of the sphere is 1.4 g/cm^3, the dielectric constant of the liquid is _________ $\left(\tan 37° = \frac{3}{4}\right)$.

15. Two charges q and 3q are separated by a distance 'r' in air. At a distance x from charge q, the resultant electric field is zero. The value of x is :
(1) $\frac{(1+\sqrt{3})}{r}$
(2) $\frac{r}{3(1+\sqrt{3})}$
(3) $\frac{r}{(1+\sqrt{3})}$
(4) $r(1+\sqrt{3})$

16. Force between two point charges q_1 and q_2 placed in vacuum at 'r' cm apart is F. Force between them when placed in a medium having dielectric K = 5 at 'r/5' cm apart will be:
(1) F/25 (2) 5F
(3) F/5 (4) 25F

17. The distance between charges +q and –q is $2l$ and between +2 q and -2 q is $4l$. The electrostatic potential at point P at a distance r from centre O is $-\alpha\left[\frac{ql}{r^2}\right]\times 10^9 V$, where the value of α is ______.
(Use $\frac{1}{4\pi\varepsilon_0} = 9\times 10^9\ Nm^2C^{-2}$)



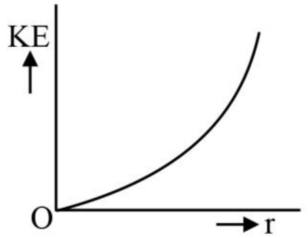
SOLUTION - CLICK

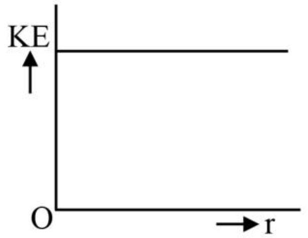
Answer Key

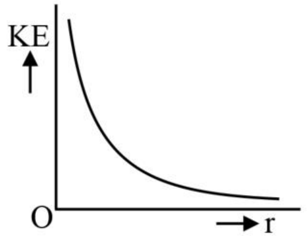
1. 3
2. 1
3. 3
4. 3
5. 3
6. 4
7. 2
8. 8
9. 2
10. 8
11. 3
12. 2
13. 2
14. 2
15. 3
16. 2
17. 27

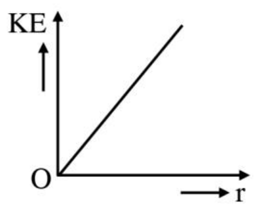
SOLUTION - CLICK

1. An infinitely long positively charged straight thread has a linear charge density λ Cm^{-1}. An electron revolves along a circular path having axis along the length of the wire. The graph that correctly represents the variation of the kinetic energy of electron as a function of radius of circular path from the wire is :

(1) 

(2) 

(3) 

(4) 

2. An infinite plane sheet of charge having uniform surface charge density $+\sigma_s$ C/m^2 is placed on x-y plane. Another infinitely long line charge having uniform linear charge density $+\lambda_e$ C/m is placed at z = 4m plane and parallel to y-axis. If the magnitude values $|\sigma_s| = 2\,|\lambda_e|$ then at point (0, 0, 2), the ratio of magnitudes of electric field values due to sheet charge to that of line charge is $\pi\sqrt{n} : 1$. The value of n is________.

3. A charge q is placed at the center of one of the surface of a cube. The flux linked with the cube is :-

(1) $\frac{q}{4\epsilon_0}$ (2) $\frac{q}{2\epsilon_0}$

(3) $\frac{q}{8\epsilon_0}$ (4) Zero

4. In hydrogen like system the ratio of coulombian force and gravitational force between an electron and a proton is in the order of:

(1) 10^{39} (2) 10^{19}

(3) 10^{29} (4) 10^{36}

5. The vehicles carrying inflammable fluids usually have metallic chains touching the ground :

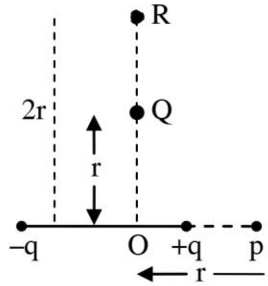
(1) To conduct excess charge due to air friction to ground and prevent sparking.

(2) To alert other vehicles.

(3) To protect tyres from catching dirt from ground.

(4) It is a custom.

6. The electric field at point p due to an electric dipole is E. The electric field at point R on equitorial line will be $\frac{E}{x}$. The value of x :



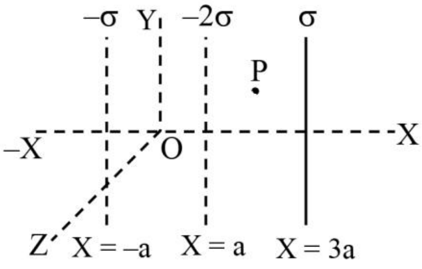
7. σ is the uniform surface charge density of a thin spherical shell of radius R. The electric field at any point on the surface of the spherical shell is :

(1) $\sigma/\epsilon_0 R$ (2) $\sigma/2\epsilon_0$

(3) σ/ϵ_0 (4) $\sigma/4\epsilon_0$

SOLUTION - [CLICK]

8. Three infinitely long charged thin sheets are placed as shown in figure. The magnitude of electric field at the point P is $\frac{x\sigma}{\epsilon_0}$. The value of x is ________ (all quantities are measured in SI units).

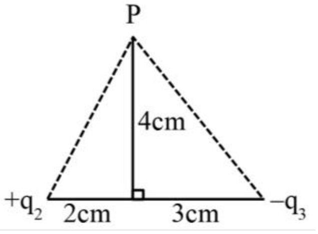


9. Two identical conducting spheres P and S with charge Q on each, repel each other with a force 16N. A third identical uncharged conducting sphere R is successively brought in contact with the two spheres. The new force of repulsion between P and S is :
(1) 4 N (2) 6 N
(3) 1 N (4) 12 N

10. Two charged conducting spheres of radii a and b are connected to each other by a conducting wire. The ratio of charges of the two spheres respectively is:
(1) $\sqrt{ab}$ (2) ab
(3) $\frac{a}{b}$ (4) $\frac{b}{a}$

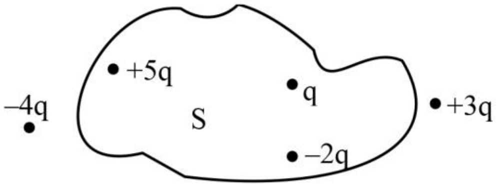
11. An electric field, $\vec{E} = \frac{2\hat{i}+6\hat{j}+8\hat{k}}{\sqrt{6}}$ passes through the surface of 4 m^2 area having unit vector $\hat{n} = \left(\frac{2\hat{i}+\hat{j}+\hat{k}}{\sqrt{6}}\right)$. The electric flux for that surface is ________ V m.

12. If the net electric field at point P along Y axis is zero, then the ratio of $\left|\frac{q_2}{q_3}\right|$ is $\frac{8}{5\sqrt{x}}$, where x = …………..



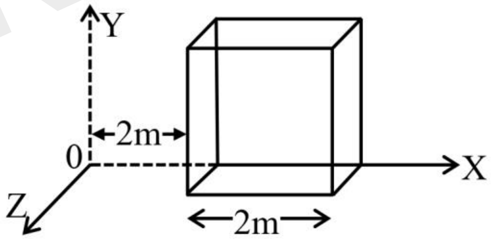
13. At the centre of a half ring of radius R = 10 cm and linear charge density 4n C m^{-1}, the potential is x π V. The value of x is ________.

14. Five charges +q, +5q, –2q, +3q and –4q are situated as shown in the figure. The electric flux due to this configuration through the surface S is :



(1) $\frac{5q}{\epsilon_0}$ (2) $\frac{4q}{\epsilon_0}$
(3) $\frac{3q}{\epsilon_0}$ (4) $\frac{q}{\epsilon_0}$

15. An electric field $\vec{E} = (2x\hat{i})NC^{-1}$ exists in space. A cube of side 2m is placed in the space as per figure given below. The electric flux through the cube is ……………… Nm^2/C.



SOLUTION - CLICK

Answer Key

1. 2
2. 16
3. 2
4. 1
5. 1
6. 16
7. 3
8. 2
9. 2
10. 3
11. 12
12. 5
13. 36
14. 2
15. 16

SOLUTION - CLICK

1. Effective capacitance of parallel combination of two capacitors C_1 and C_2 is $10\mu F$. When these capacitors are individually connected to a voltage source of 1V, the energy stored in the capacitor C_2 is 4 times that of C_1. If these capacitors are connected in series, their effective capacitance will be

(a) $1.6\mu F$ (b) $8.4\mu F$
(c) $3.2\mu F$ (d) $4.2\mu F$

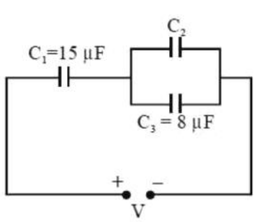
2. A parallel plate capacitor has plates of area A separated by distance 'd' between them. It is filled with a dielectric which has a dielectric constant that varies as $k(x) = K(1+\alpha x)$ where 'x' is the distance measured from one of the plates. If $(\alpha d) << 1$, the total capacitance of the system is best given by the expression

(a) $\frac{A\varepsilon_0 K}{d}\left(1+\left(\frac{\alpha d}{2}\right)^2\right)$ (b) $\frac{AK\varepsilon_0}{d}\left(1+\frac{\alpha d}{2}\right)$
(c) $\frac{A\varepsilon_0 K}{d}\left(1+\frac{\alpha^2 d^2}{2}\right)$ (d) $\frac{AK\varepsilon_0}{d}(1+\alpha d)$

3. Which of the following will NOT be observed when a multimeter (operating in resistance measuring mode) probes connected across a component, are just reversed?

(a) Multimeter shows NO deflection in both cases i.e. before and after reversing the probes if the chosen component is capacitor.
(b) Multimeter shows a deflection,accompanied by a splash of light out of connected component in one direction and NO deflection on reversing the probes if the chosen component is LED.
(c) Multimeter shows NO deflection in both cases i.e. before and after reversing the probes if the chosen compoenent is metal wire.
(d) Multimeter shows an equal deflection in both cases i.e. before and after reversing the probes if the chosen component is resistor.

4. In the circuit shown in the figure, the total charge is $750\ \mu C$ and the voltage across capacitor C_2 is 20 V. Then the charge on capacitor C_2 is



(a) 590 μC (b) 450 μC
(c) 650 μC (d) 160 μC

5. A capacitor C is fully charged with voltage V_0. After disconnecting the voltage source, it is connected in parallel with another uncharged capacitor of capacitance $C/2$. The energy loss in the process after the charge is distributed between the two capacitors is

(a) $\frac{1}{6}CV_0^2$ (b) $\frac{1}{2}CV_0^2$
(c) $\frac{1}{3}CV_0^2$ (d) $\frac{1}{4}CV_0^2$

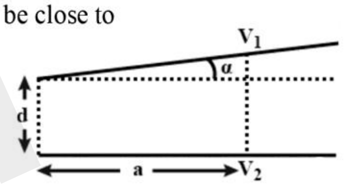
6. Two capacitors of capacitances C and $2C$ are charged to potential differences V and $2V$, respectively. These are then connected in parallel in such a manner that the positive terminal of one is connected to the negative terminal of the other. The final energy of this configuration is

(a) $\frac{9}{2}CV^2$ (b) $\frac{25}{6}CV^2$
(c) zero (d) $\frac{3}{2}CV^2$

7. A 10 mF capacitor is fully charged to a potential difference of 50 V. After removing the source voltage it is connected to an uncharged capacitor in parallel. Now the potential difference across them becomes 20 V. The capacitance of the second capacitor is

(a) 10 μF (b) 15 μF
(c) 20 μF (d) 30 μF

8. A capacitor is made of two square plates each of side a making a very small angle α between them, as shown in figure. The capacitance will be close to

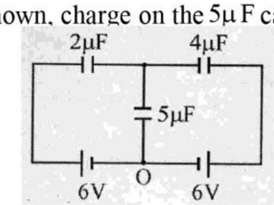


(a) $\frac{\varepsilon_0 a^2}{d}\left(1-\frac{\alpha a}{4d}\right)$
(b) $\frac{\varepsilon_0 a^2}{d}\left(1+\frac{\alpha a}{d}\right)$
(c) $\frac{\varepsilon_0 a^2}{d}\left(1-\frac{\alpha a}{2d}\right)$ (d) $\frac{\varepsilon_0 a^2}{d}\left(1-\frac{3\alpha a}{2d}\right)$

9. A parallel plate capacitor has plate of length 'l', width 'w' and separation of plates is 'd'. It is connected to a battery of emf V. A dielectric slab of the same thickness 'd' and of dielectric constant $k = 4$ is being inserted between the plates of the capacitor. At what length of the slab inside plates, will be energy stored in the capacitor be two times the initial energy stored?

(a) $l/4$ (b) $l/2$
(c) $l/3$ (d) $2l/3$

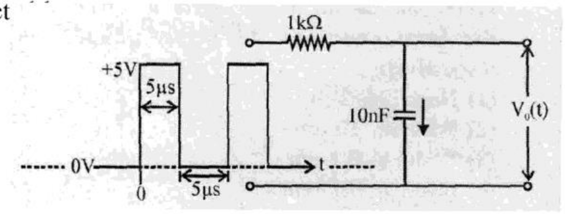
10. In the circuit shown, charge on the $5\mu F$ capacitor is



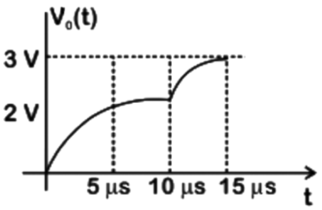
(a) $5.45\mu C$ (b) $16.36\mu C$
(c) $10.90\mu C$ (d) $18.00\mu C$

SOLUTION

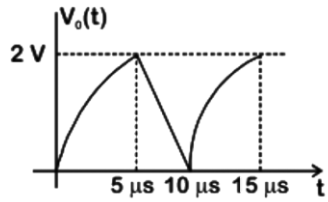
11. For the given input voltage waveform $V_{in}(t)$, the output voltage waveform $V_D(t)$, across the capacitor is correctly depict



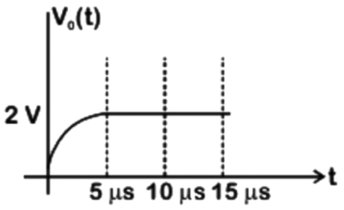
(a)



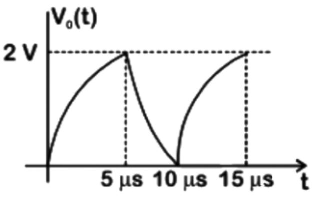
(b)



(c)



(d)



12. A $5\ \mu F$ capacitor is charged fully by a 220 V supply. It is then disconnected from the supply and is connected in series to another uncharged $2.5\ \mu F$ capacitor. If the energy change during the charge redistribution is $\frac{X}{100}$ J then value of X to the nearest integer is

13. A 60 pF capacitor is fully charged by a 20 V supply. It is then disconnected from the supply and is connected to another uncharged 60 pF capacitor in parallel. The electrostatic energy that is lost in this process by the time the charge is redistributed between them is (in nJ)

14. An ideal cell of emf 10 V is connected in circuit shown in figure. Each resistance is $2\ \Omega$. The potential difference (in V) across the capacitor when it is fully charged is_____.

SOLUTION

ANSWER KEY

1. a
2. b
3. a
4. a
5. a
6. d
7. b
8. c
9. c
10. b
11. a
12. 4
13. 6
14. 8

Feb Attempt

1. Two equal capacitors are first connected in series and then in parallel. The ratio of the equivalent capacities in the two cases will be:

(1) 4 : 1 (2) 2 : 1

(3) 1 : 4 (4) 1 : 2

2. An electron with kinetic energy K_1 enters between parallel plates of a capacitor at an angle 'α' with the plates. It leaves the plates at angle 'β' with kinetic energy K_2. Then the ratio of kinetic energies $K_1 : K_2$ will be :

(1) $\frac{\sin^2\beta}{\cos^2\alpha}$ (2) $\frac{\cos^2\beta}{\cos^2\alpha}$ (3) $\frac{\cos\beta}{\cos\alpha}$ (4) $\frac{\cos\beta}{\sin\alpha}$

3. Consider the combination of 2 capacitors C_1 and C_2, with $C_2 > C_1$, when connected in parallel, the equivalent capacitance is $\frac{15}{4}$ time the equivalent capacitance of the same connected in series. Calculate the ratio of capacitors, $\frac{C_2}{C_1}$.

(1) $\frac{15}{11}$ (2) $\frac{111}{80}$

(3) $\frac{29}{15}$ (4) $\frac{15}{4}$

March Attempt

1. For changing the capacitance of a given parallel plate capacitor, a dielectric material of dielectric constant K is used, which has the same area as the plates of the capacitor. The thickness of the dielectric slab is $\frac{3}{4}$d, where 'd' is the separation between the plates of parallel plate capacitor. The new capacitance (C') in terms of original capacitance (C_0) is given by the following relation :

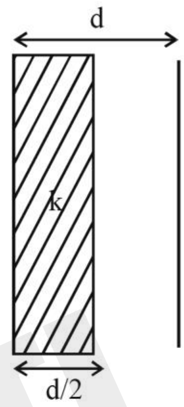
(1) $C' = \frac{3+K}{4K}C_0$ (2) $C' = \frac{4+K}{3}C_0$

(3) $C' = \frac{4K}{K+3}C_0$ (4) $C' = \frac{4}{3+K}C_0$

2. In a parallel plate capacitor set up, the plate area of capacitor is 2 m² and the plates are separated by 1m. If the space between the plates are filled with a dielectric material of thickness 0.5 m and area 2m² (see fig.) the capacitance of the set-up will be ______ ε_0.

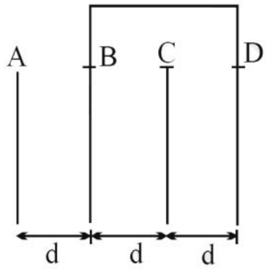
(Dielectric constant of the material = 3.2)

(Round off to the Nearest Integer)



3. Four identical rectangular plates with length, l = 2 cm and breadth, b = $\frac{3}{2}$ cm are arranged as shown in figure. The equivalent capacitance between A and C is $\frac{x\varepsilon_0}{d}$. The value of x is ___.

(Round off to the Nearest Integer)

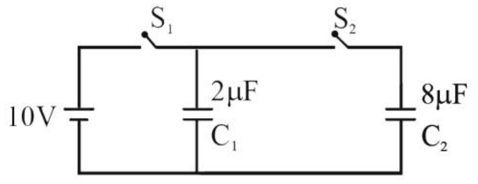


4. A parallel plate capacitor whose capacitance C is 14 pF is charged by a battery to a potential difference V = 12V between its plates. The charging battery is now disconnected and a porcelin plate with k = 7 is inserted between the plates, then the plate would oscillate back and forth between the plates with a constant mechanical energy of ______ pJ.

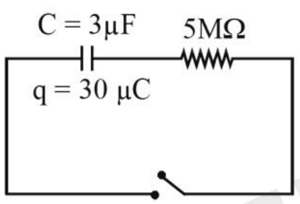
(Assume no friction)

SOLUTION

5. A 2 μF capacitor C_1 is first charged to a potential difference of 10 V using a battery.Then the battery is removed and the capacitor is connected to an uncharged capacitor C_2 of 8μF. The charge in C_2 on equilibrium condition is_______μC. (Round off to the Nearest Integer)



6. The circuit shown in the figure consists of a charged capacitor of capacity 3 μF and a charge of 30 μC. At time t = 0, when the key is closed, the value of current flowing through the 5 MΩ resistor is 'x' μ-A. The value of 'x to the nearest integer is _______.



7. A parallel plate capacitor has plate area 100 m^2 and plate separation of 10 m. The space between the plates is filled up to a thickness 5 m with a material of dielectric constant of 10. The resultant capacitance of the system is 'x' pF. The value of ε_0 = 8.85 × 10^{-12} F.m^{-1}. The value of 'x' to the nearest integer is_____.

July Attempt

1. A parallel plate capacitor with plate area 'A' and distance of separation 'd' is filled with a dielectric. What is the capacity of the capacitor when permittivity of the dielectric varies as :

$$\varepsilon(x) = \varepsilon_0 + kx, \text{ for } \left(0 < x \le \frac{d}{2}\right)$$

$$\varepsilon(x) = \varepsilon_0 + k(d - x), \text{ for } \left(\frac{d}{2} \le x \le d\right)$$

(1) $\left(\varepsilon_0 + \frac{kd}{2}\right)^{2/kA}$ (2) $\frac{kA}{2\ln\left(\frac{2\varepsilon_0 + kd}{2\varepsilon_0}\right)}$

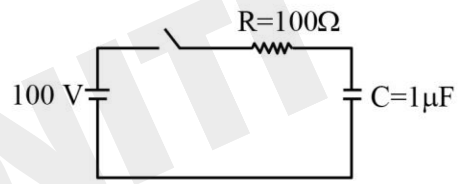
(3) 0 (4) $\frac{kA}{2}\ln\left(\frac{2\varepsilon_0}{2\varepsilon_0 - kd}\right)$

2. If q_f is the free charge on the capacitor plates and q_b is the bound charge on the dielectric slab of dielectric constant k placed between the capacitor plates, then bound charge q_b can be expressed as :

(1) $q_b = q_f\left(1 - \frac{1}{\sqrt{k}}\right)$ (2) $q_b = q_f\left(1 - \frac{1}{k}\right)$

(3) $q_b = q_f\left(1 + \frac{1}{\sqrt{k}}\right)$ (4) $q_b = q_f\left(1 + \frac{1}{k}\right)$

3



A capacitor of capacitance C=1 μF is suddenly connected to a battery of 100 volt through a resistance R = 100 Ω. The time taken for the capacitor to be charged to get 50 V is :

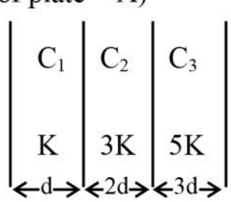
[Take ln 2 = 0.69]

(1) 1.44 × 10^{-4} s (2) 3.33 × 10^{-4} s

(3) 0.69 × 10^{-4} s (4) 0.30 × 10^{-4} s

4. In the reported figure, a capacitor is formed by placing a compound dielectric between the plates of parallel plate capacitor. The expression for the capacity of the said capacitor will be :

(Given area of plate = A)



(1) $\frac{15}{34}\frac{K\varepsilon_0 A}{d}$ (2) $\frac{15}{6}\frac{K\varepsilon_0 A}{d}$

(3) $\frac{25}{6}\frac{K\varepsilon_0 A}{d}$ (4) $\frac{9}{6}\frac{K\varepsilon_0 A}{d}$

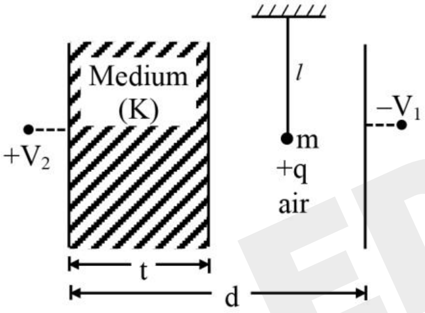
SOLUTION

5. Two capacitors of capacities 2C and C are joined in parallel and charged up to potential V. The battery is removed and the capacitor of capacity C is filled completely with a medium of dielectric constant K. The potential difference across the capacitors will now be :

(1) $\frac{V}{K+2}$ (2) $\frac{V}{K}$

(3) $\frac{3V}{K+2}$ (4) $\frac{3V}{K}$

6. A simple pendulum of mass 'm', length 'l' and charge '+q' suspended in the electric field produced by two conducting parallel plates as shown. The value of deflection of pendulum in equilibrium position will be



(1) $\tan^{-1}\left[\frac{q}{mg}\times\frac{C_1(V_2-V_1)}{(C_1+C_2)(d-t)}\right]$

(2) $\tan^{-1}\left[\frac{q}{mg}\times\frac{C_2(V_2-V_1)}{(C_1+C_2)(d-t)}\right]$

(3) $\tan^{-1}\left[\frac{q}{mg}\times\frac{C_2(V_1+V_2)}{(C_1+C_2)(d-t)}\right]$

(4) $\tan^{-1}\left[\frac{q}{mg}\times\frac{C_1(V_1+V_2)}{(C_1+C_2)(d-t)}\right]$

SOLUTION

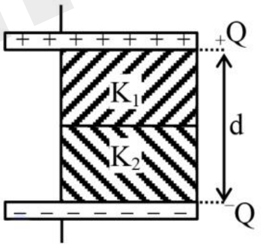
August Attempt

1. The material filled between the plates of a parallel plate capacitor has resistivity 200 Ωm. The value of capacitance of the capacitor is 2 pF. If a potential difference of 40 V is applied across the plates of the capacitor, then the value of leakage current flowing out of the capacitor is : (given the value of relative permitivity of material is 50)

(1) 9.0 μA (2) 9.0 mA

(3) 0.9 mA (4) 0.9 μA

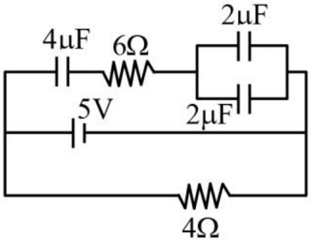
2. A parallel - plate capacitor with plate area A has separation d between the plates. Two dielectric slabs of dielectric constant K_1 and K_2 of same area A/2 and thickness d/2 are inserted in the space between the plates. The capacitance of the capacitor will be given by :



(1) $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{K_1K_2}{K_1+K_2}\right)$ (3) $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{K_1+K_2}{K_1K_2}\right)$

(2) $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{K_1K_2}{2(K_1+K_2)}\right)$ (4) $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{2(K_1+K_2)}{K_1K_2}\right)$

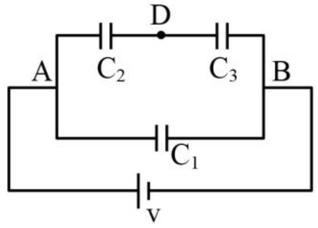
3. Calculate the amount of charge on capacitor of 4 μF. The internal resistance of battery is 1Ω :



(1) 8 μC (2) zero

(3) 16 μC (4) 4 μC

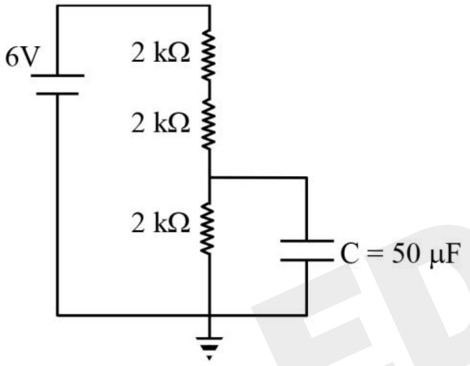
4. Three capacitors $C_1 = 2\mu F$, $C_2 = 6\ \mu F$ and $C_3 = 12\ \mu F$ are connected as shown in figure. Find the ratio of the charges on capacitors C_1, C_2 and C_3 respectively :



(1) 2 : 1 : 1 (2) 2 : 3 : 3

(3) 1 : 2 : 2 (4) 3 : 4 : 4

5. A capacitor of 50 μF is connected in a circuit as shown in figure. The charge on the upper plate of the capacitor is__________μC.



6. A parallel plate capacitor of capacitance 200 μF is connected to a battery of 200 V. A dielectric slab of dielectric constant 2 is now inserted into the space between plates of capacitor while the battery remain connected. The change in the electrostatic energy in the capacitor will be_____J.

7. A capacitor is connected to a 20 V battery through a resistance of 10Ω. It is found that the potential difference across the capacitor rises to 2 V in 1 μs. The capacitance of the capacitor is ....μF.

Given : $\ln\left(\frac{10}{9}\right) = 0.105$

(1) 9.52 (2) 0.95

(3) 0.105 (4) 1.85

SOLUTION

ANSWER KEY

Feb Attempt

1. 3
2. 2
3. Bonus

March Attempt

1. 3
2. 3
3. 2
4. 864
5. 16
6. 2
7. 161

July Attempt

1. 2
2. 2
3. 3
4. 1
5. 3
6. 3

August Attempt

1. 3
2. 1
3. 1
4. 3
5. 100
6. 4
7. 2

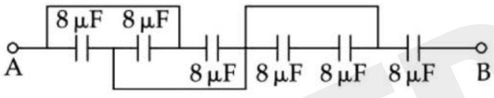
1. A parallel plate capacitor is formed by two plates each of area $30\pi\ \text{cm}^2$ separated by 1 mm. A material of dielectric strength $3.6 \times 10^7\ \text{Vm}^{-1}$ is filled between the plates. If the maximum charge that can be stored on the capacitor without causing any dielectric breakdown is 7×10^{-6} C, the value of dielectric constant of the material is :

$$\left\{\text{Use}: \frac{1}{4\pi\varepsilon_0} = 9\times10^9\ \text{Nm}^2\text{C}^{-2}\right\}$$

(A) 1.66 (B) 1.75
(C) 2.25 (D) 2.33

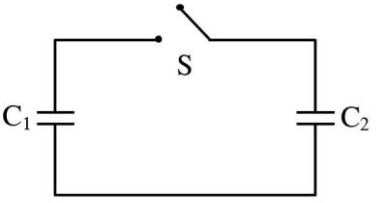
2. If the charge on a capacitor is increased by 2 C, the energy stored in it increases by 44%. The original charge on the capacitor is (in C) :
(A) 10 (B) 20
(C) 30 (D) 40

3. The equivalent capacitance between points A and B in below shown figure will be _____μF.



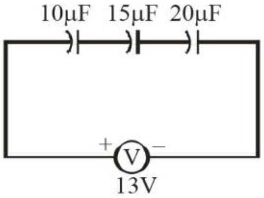
4. Two metallic plates form a parallel plate capacitor. The distance between the plates is 'd'. A metal sheet of thickness $\frac{d}{2}$ and of area equal to area of each plate is introduced between the plates. What will be the ratio of the new capacitance to the original capacitance of the capacitor ?
(A) 2:1 (B) 1:2
(C) 1:4 (D) 4:1

5. Two capacitors having capacitance C_1 and C_2 respectively are connected as shown in figure. Initially, capacitor C_1 is charged to a potential difference V volt by a battery. The battery is then removed and the charged capacitor C_1 is now connected to uncharged capacitor C_2 by closing the switch S. The amount of charge on the capacitor C_2, after equilibrium is :



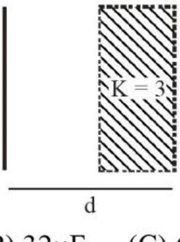
(A) $\frac{C_1C_2}{(C_1+C_2)}V$ (B) $\frac{(C_1+C_2)}{C_1C_2}V$
(C) $(C_1 + C_2)V$ (D) $(C_1 - C_2)V$

6. The charge on capacitor of capacitance 15μF in the figure given below is :



(A) 60μc (B) 130μc (C) 260 μc (D) 585 μc

7. A parallel plate capacitor with plate area A and plate separation d=2 m has a capacitance of 4 μF. The new capacitance of the system if half of the space between them is filled with a dielectric material of dielectric constant K=3 (as shown in figure) will be :



(A) 2μF (B) 32μF (C) 6μF (D) 8μF

SOLUTION

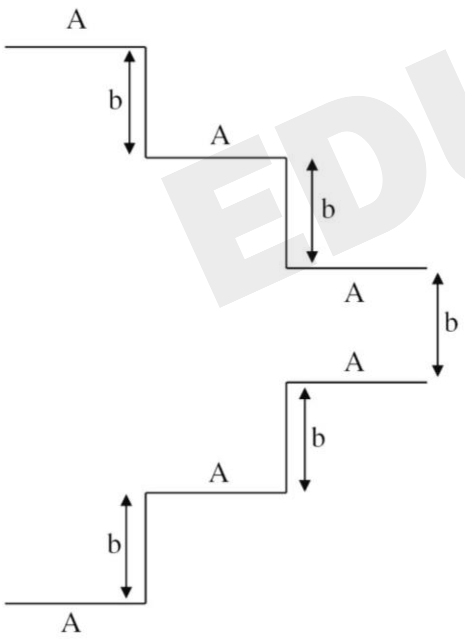
8. A force of 10N acts on a charged particle placed between two plates of a charged capacitor. If one plate of capacitor is removed, then the force acting on that particle will be :

(A) 5 N (B) 10 N

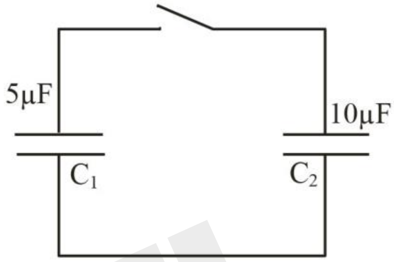
(C) 20 N (D) Zero

9. A capacitor of capacitance 50 pF is charged by 100 V source. It is then connected to another uncharged identical capacitor. Electrostatic energy loss in the process is ____ nJ.

10. A paralle plate capacitor is made up of stair like structure with a palte area A of each stair and that is connected with a wire of length b, as shown in the figure. The capacitance of the arrangement is $\frac{x}{15}\frac{\varepsilon_0 A}{b}$. The value of x is _______ .



11. A capacitor C_1 of capacitance $5\mu F$ is charged to a potential of 30 V using a battery. The battery is then removed and the charged capacitor is connected to an uncharged capacitor C_2 of capacitance $10\mu F$ as shown in figure. When the switch is closed charge flows between the capacitors. At equilibrium, the charge on the capacitor C_2 is ________ μC.



12. A parallel plate capacitor filled with a medium of dielectric constant 10, is connected across a battery and is charged. The dielectric slab is replaced by another slab of dielectric constant 15. Then the energy of capacitor will :

(A) increase by 50% (B) decrease by 15%

(C) increase by 25% (D) increase by 33%

13. A capacitor is discharging through a resistor R. Consider in time t_1, the energy stored in the capacitor reduces to half of its initial value and in time t_2, the charge stored reduces to one eighth of its initial value. The ratio t_1/t_2 will be :

(A) 1/2 (B) 1/3

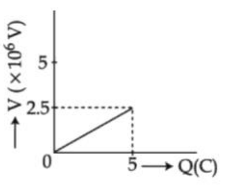
(C) 1/4 (D) 1/6

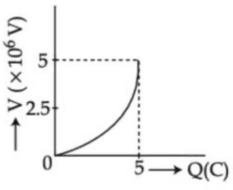
SOLUTION

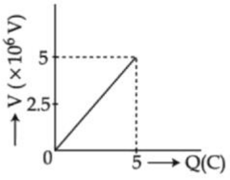
Answer Key

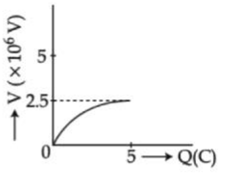
1. D
2. A
3. 6
4. A
5. A
6. A
7. C
8. A
9. 125
10. 23
11. 100
12. A
13. D

1. A condenser of 2 μF capacitance is charged steadily from 0 to 5C. Which of the following graph represents correctly the variation of potential difference (V) across it's plates with respect to the charge (Q) on the condenser ?

(A) 

(B) 

(C) 

(D) 

2. Capacitance of an isolated conducting sphere of radius R_1 becomes n times when it is enclosed by a concentric conducting sphere of radius R_2 connected to earth. The ratio of their radii $\left(\frac{R_2}{R_1}\right)$ is:

(A) $\frac{n}{n-1}$ (B) $\frac{2n}{2n+1}$

(C) $\frac{n+1}{n}$ (D) $\frac{2n+1}{n}$

3. Two parallel plate capacitors of capacity C and 3C are connected in parallel combination and charged to a potential difference 18V. The battery is then disconnected and the space between the plates of the capacitor of capacity C is completely filled with a material of dielectric constant 9. The final potential difference across the combination of capacitors will be _______ V

SOLUTION

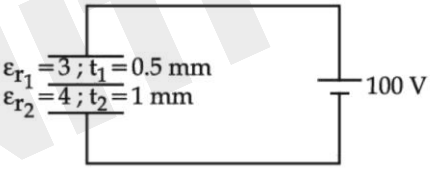
4. The total charge on the system of capacitance $C_1 = 1\mu F$, $C_2 = 2\mu F$, $C_3 = 4\mu F$ and $C_4 = 3\mu F$ connected in parallel is

(Assume a battery of 20V is connected to the combination)

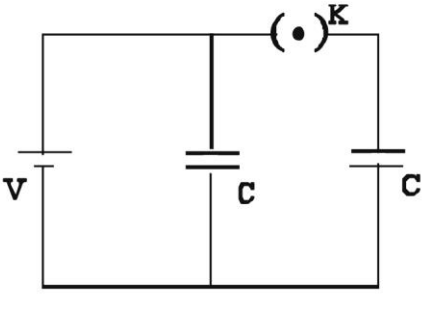
(A) 200μC (B) 200C

(C) 10μC (D) 10C

5. A composite parallel plate capacitor is made up of two different dielectric materials with different thickness $(t_1 \text{ and } t_2)$ as shown in figure. The two different dielectric material are separated by a conducting foil F. The voltage of the conducting foil is ____V.



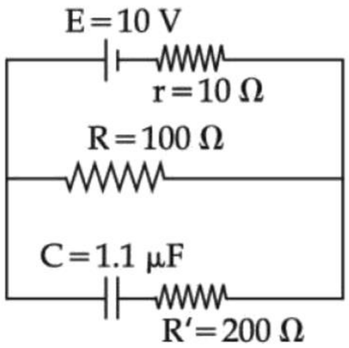
6. A source of potential difference V is connected to the combination of two identical capacitors as shown in the figure. When key 'K' is closed, the total energy stored across the combination is E_1. Now key 'K' is opened and dielectric of dielectric constant 5 is introduced between the plates of the capacitors. The total energy stored across the combination is now E_2. The ratio E_1/E_2 will be :



(A) $\frac{1}{10}$ (B) $\frac{2}{5}$

(C) $\frac{5}{13}$ (D) $\frac{5}{26}$

7. As show in the figure, in steady state, the charge stored in the capacitor is……. $\times 10^{-6}$C.



8. A parallel plate capacitor with width 4 cm, length 8 cm and separation between the plates of 4mm is connected to a battery of 20 V. A dielectric slab of dielectric constant 5 having length 1cm, width 4 cm and thickness 4 mm is inserted between the plates of parallel plate capacitor. The electrostatic energy of this system will be……… ϵ_0 J.

(Where ϵ_0 is the permittivity of free space)

9. Two capacitors, each having capacitance $40\ \mu F$ are connected in series. The space between one of the capacitors is filled with dielectric material of dielectric constant K such that the equivalence capacitance of the system became $24\ \mu F$. The value of K will be :

(A) 1.5 (B) 2.5

(C) 1.2 (D) 3

10. A slab of dielectric constant K has the same cross-sectional area as the plates of a parallel plate capacitor and thickness $\frac{3}{4}d$, where d is the separation of the plates. The capacitance of the capacitor when the slab is inserted between the plates will be :

(Given C_o = capacitance of capacitor with air as medium between plates.)

(A) $\frac{4KC_0}{3+K}$ (B) $\frac{3KC_0}{3+K}$

(C) $\frac{3+K}{4KC_0}$ (D) $\frac{K}{4+K}$

11. Two identical thin metal plates has charge q_1 and q_2 respectively such that $q_1 > q_2$. The plates were brought close to each other to form a parallel plate capacitor of capacitance C. The potential difference between them is :

(A) $\frac{(q_1+q_2)}{C}$ (B) $\frac{(q_1-q_2)}{C}$

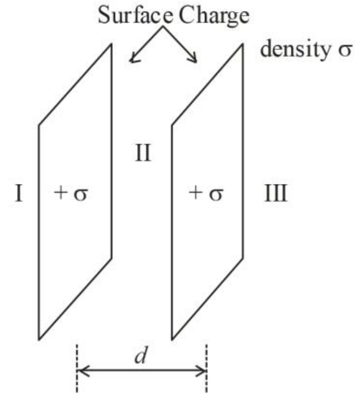
(C) $\frac{(q_1-q_2)}{2C}$ (D) $\frac{2(q_1-q_2)}{C}$

SOLUTION

ANSWER KEY

1. A
2. A
3. 6
4. A
5. 60
6. C
7. 10
8. 240
9. A
10. A
11. C

1. Let σ be the uniform surface charge density of two infinite thin plane sheets shown in figure. Then the electric fields in three different region E_I, E_{II} and E_{III} are:



(1) $\vec{E}_I = \frac{2\sigma}{\epsilon_0}\hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{2\sigma}{\epsilon_0}\hat{n}$

(2) $\vec{E}_I = 0, \vec{E}_{II} = \frac{\sigma}{\epsilon_0}\hat{n}, \vec{E}_{III} = 0$

(3) $\vec{E}_I = \frac{\sigma}{2\epsilon_0}\hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{\sigma}{2\epsilon_0}\hat{n}$

(4) $\vec{E}_I = -\frac{\sigma}{\epsilon_0}\hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{\sigma}{\epsilon_0}\hat{n}$

2. **Assertion A :** Two metallic spheres are charged to the same potential. One of them is hollow and another is solid, and both have the same radii. Solid sphere will have lower charge than the hollow one.

Reason R : Capacitance of metallic spheres depend on the radii of spheres.

In the light of the above statements, choose the correct answer from the options given below.

(1) **A** is false but **R** is true

(2) Both **A** and **R** are true and **R** is the correct explanation of **A**

(3) **A** is true but **R** is false

(4) Both **A** and **R** are true but **R** is not the correct explanation of **A**

3. A parallel plate capacitor with air between the plate has a capacitance of 15pF. The separation between the plate becomes twice and the space between them is filled with a medium of dielectric constant 3.5. Then the capacitance becomes $\frac{x}{4}$ pF. The value of x is __________.

4. A parallel plate capacitor has plate area $40 cm^2$ and plates separation 2 mm. The space between the plates is filled with a dielectric medium of a thickness 1 mm and dielectric constant 5. The capacitance of the system is :

(1) $24\varepsilon_0$ F
(2) $\frac{3}{10}\varepsilon_0$ F
(3) $\frac{10}{3}\varepsilon_0$ F
(4) $10\varepsilon_0$ F

5. A capacitor has capacitance 5μF when it's parallel plates are separated by air medium of thickness d. A slab of material of dielectric constant 1.5 having area equal to that of plates but thickness $\frac{d}{2}$ is inserted between the plates. Capacitance of the capacitor in the presence of slab will be _____μF.

6. A capacitor of capacitance 900 μF is charged by a 100 V battery. The capacitor is disconnected from the battery and connected to another uncharged identical capacitor such that one plate of uncharged capacitor connected to positive plate and another plate of uncharged capacitor connected to negative plate of the charged capacitor. The loss of energy in this process is measured as $x \times 10^{-2}$ J. The value of x is _____.

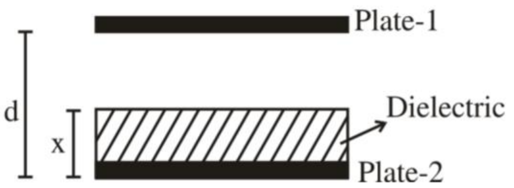
7. Two parallel plate capacitors C_1 and C_2 each having capacitance of 10 μF are individually charged by a 100 V D.C. source. Capacitor C_1 is kept connected to the source and a dielectric slab is inserted between it plates. Capacitor C_2 is disconnected from the source and then a dielectric slab is inserted in it. Afterwards the capacitor C_1 is also disconnected from the source and the two capacitors are finally connected in parallel combination. The common potential of the combination will be ________V. (Assuming Dielectric constant = 10)

SOLUTION

ANSWER KEY

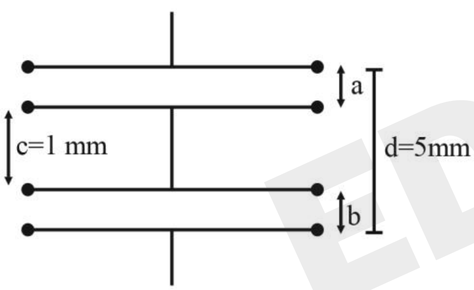
1. 4
2. 1
3. 105
4. 3
5. 6
6. 225
7. 55

1. A parallel plate capacitor with plate area A and plate separation d is filled with a dielectric material of dielectric constant K = 4. The thickness of the dielectric material is x, where x < d.

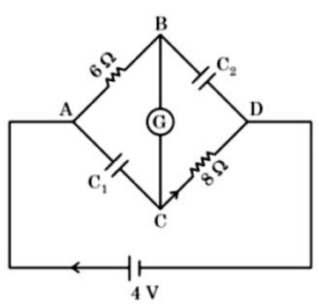


Let C_1 and C_2 be the capacitance of the system for $x = \frac{1}{3}d$ and $x = \frac{2d}{3}$, respectively. If $C_1 = 2\mu F$ the value of C_2 is _______ μF

2. As shown in the figure, two parallel plate capacitors having equal plate area of 200 cm^2 are joined in such a way that $a \neq b$. The equivalent capacitance of the combination is x $\in_0$F. The value of x is_______.



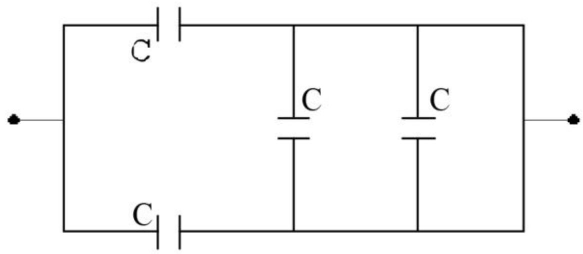
3. In this figure the resistance of the coil of galvanometer G is 2 Ω. The emf of the cell is 4 V. The ratio of potential difference across C_1 and C_2 is:



(1) 1 (2) $\frac{4}{5}$ (3) $\frac{3}{4}$ (4) $\frac{5}{4}$

4. A 600 pF capacitor is charged by 200V supply. It is then disconnected from the supply and is connected to another uncharged 600 pF capacitor. Electrostatic energy lost in the process is __________ μJ.

5. The equivalent capacitance of the combination shown is



(1) $\frac{C}{2}$ (2) 4C

(3) 2C (4) $\frac{5}{3}C$

6. The distance between two plates of a capacitor is d and its capacitance is C_1, when air is the medium between the plates. If a metal sheet of thickness $\frac{2d}{3}$ and of same area as plate is introduced between the plates, the capacitance of the capacitor becomes C_2. The ratio $\frac{C_2}{C_1}$ is:

(1) 2 : 1

(2) 4 : 1

(3) 3 : 1

(4) 1 : 1

7. A parallel plate capacitor of capacitance 2 F is charged to a potential V. The energy stored in the capacitor is E_1. The capacitor is now connected to another uncharged identical capacitor in parallel combination. The energy stored in the combination is E_2. The ratio E_2/E_1 is :

(1) 2 : 1 (2) 1 : 2

(3) 1 : 4 (4) 2 : 3

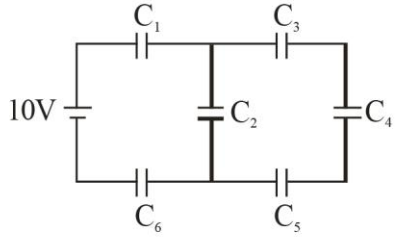
SOLUTION

8. A capacitor of capacitance C is charged to a potential V. The flux of the electric field through a closed surface enclosing the positive plate of the capacitor is:

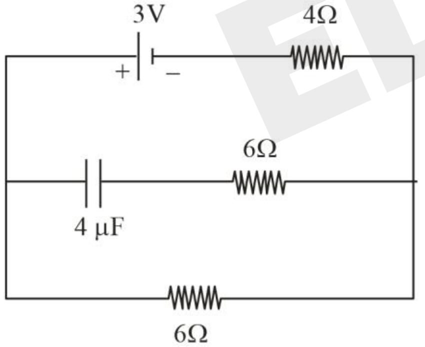
(1) $\frac{CV}{2\varepsilon_0}$ (2) $\frac{2CV}{\varepsilon_0}$

(3) $\frac{CV}{\varepsilon_0}$ (4) Zero

9. In the given circuit, $C_1 = 2\ \mu F$, $C_2 = 0.2\ \mu F$, $C_3 = 2\ \mu F$, $C_4 = 4\ \mu F$, $C_5 = 2\ \mu F$, $C_6 = 2\ \mu F$, the charge stored on capacitor C_4 is ______ μC.



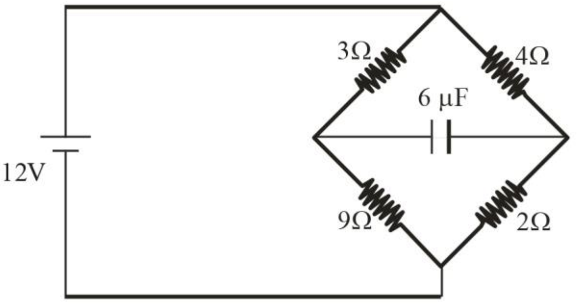
10. In the network shown below, the charge accumulated in the capacitor in steady state will be :



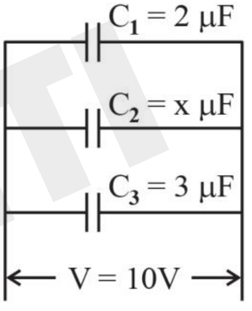
(1) 7.2 μC (2) 4.8 μC

(3) 10.3 μC (4) 12 μC

11. In the circuit shown, the energy stored in the capacitor is n μJ. The value of n is _________.



12. In the given figure the total charge stored in the combination of capacitors is 100 μC. The value of 'x' is____________ .



SOLUTION

Capacitors

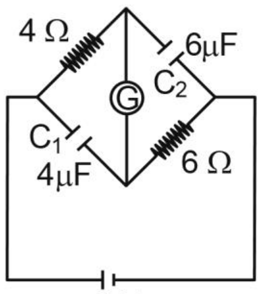
1. 3
2. 5
3. 2
4. 6
5. 3
6. 3
7. 2
8. 3
9. 4
10. 1
11. 75
12. 5

1. Two identical capacitors have same capacitance C. One of them is charged to the potential V and other to the potential 2V. The negative ends of both are connected together. When the positive ends are also joined together, the decrease in energy of the combined system is :

(1) $\frac{1}{4}CV^2$ (2) $2\ CV^2$

(3) $\frac{1}{2}CV^2$ (4) $\frac{3}{4}CV^2$

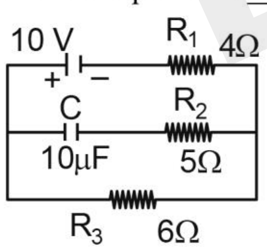
2. A galvanometer (G) of 2Ω resistance is connected in the given circuit. The ratio of charge stored in C_1 and C_2 is :



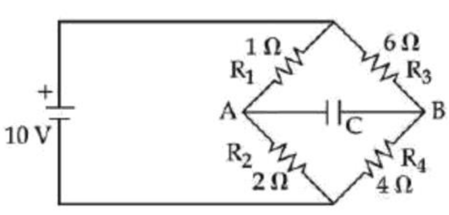
(1) $\frac{2}{3}$ (2) $\frac{3}{2}$

(3) 1 (4) $\frac{1}{2}$

3. In an electrical circuit drawn below the amount of charge stored in the capacitor is ___μC.

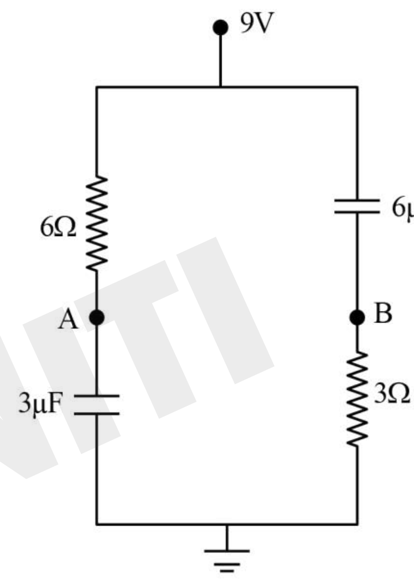


4. The charge accumulated on the capacitor connected in the following circuit is ____μC (Given C = 150 μF)



5. A 16Ω wire is bend to form a square loop. A 9V battery with internal resistance 1Ω is connected across one of its sides. If a 4μF capacitor is connected across one of its diagonals, the energy stored by the capacitor will be $\frac{x}{2}$ μJ. where x = _________.

6. In the given figure, the charge stored in 6μF capacitor, when points A and B are joined by a connecting wire is _______μC.



7. A capacitor of capacitance C and potential V has energy E. It is connected to another capacitor of capacitance 2 C and potential 2V. Then the loss of energy is $\frac{x}{3}E$, where x is _____ .

8. A parallel plate capacitor with plate separation 5 mm is charged up by a battery. It is found that on introducing a dielectric sheet of thickness 2 mm, while keeping the battery connections intact, the capacitor draws 25% more charge from the battery than before. The dielectric constant of the sheet is ____.

SOLUTION - CLICK

Answer Key

1. 1
2. 4
3. 60
4. 400
5. 81
6. 36
7. 2
8. 2

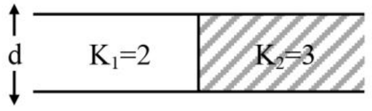
SOLUTION - CLICK

1. A parallel plate capacitor of capacitance 12.5 pF is charged by a battery connected between its plates to potential difference of 12.0 V. The battery is now disconnected and a dielectric slab ($\in_r = 6$) is inserted between the plates. The change in its potential energy after inserting the dielectric slab is ________$\times 10^{-12}$ J.

2. The electric field between the two parallel plates of a capacitor of 1.5 μF capacitance drops to one third of its initial value in 6.6 μs when the plates are connected by a thin wire. The resistance of this wire is .... Ω. (Given, log 3 = 1.1)

3. Three capacitors of capacitances 25 μF, 30 μF and 45 μF are connected in parallel to a supply of 100 V. Energy stored in the above combination is E. When these capacitors are connected in series to the same supply, the stored energy is $\frac{9}{x}E$. The value of x is ....

4. A capacitor of 10 μF capacitance whose plates are separated by 10 mm through air and each plate has area 4 cm^2 is now filled equally with two dielectric media of $K_1 = 2$, $K_2 = 3$ respectively as shown in figure. If new force between the plates is 8 N. The supply voltage is _____ V.

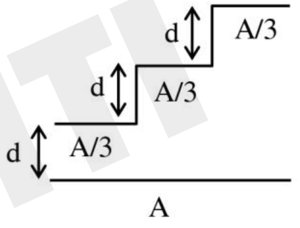


5. A capacitor has air as dielectric medium and two conducting plates of area 12 cm^2 and they are 0.6 cm apart. When a slab of dielectric having area 12 cm^2 and 0.6 cm thickness is inserted between the plates, one of the conducting plates has to be moved by 0.2 cm to keep the capacitance same as in previous case. The dielectric constant of the slab is : (Given $\in_0 = 8.834 \times 10^{-12}$ F/m)

(1) 1.50 (2) 1.33

(3) 0.66 (4) 1

6. A capacitor is made of a flat plate of area A and a second plate having a stair-like structure as shown in figure. If the area of each stair is $\frac{A}{3}$ and the height is d, the capacitance of the arrangement is:



(1) $\frac{11\varepsilon_0 A}{18d}$ (2) $\frac{13\varepsilon_0 A}{17d}$

(3) $\frac{11\varepsilon_0 A}{20d}$ (4) $\frac{18\varepsilon_0 A}{11d}$

SOLUTION - CLICK

Answer Key

1. 750
2. 4
3. 86
4. NTA gave 80 (*Question itself has some wrong data, also if you ignore it still 80 comes through incorrect concept*)
5. 1
6. 1

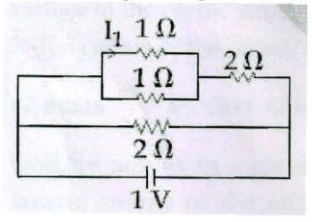
SOLUTION - CLICK

1. Consider four conducting materials copper, tungsten, mercury and aluminium with resistivity ρ_C, ρ_T, ρ_M and ρ_A respectively

(a) $\rho_M > \rho_A > \rho_C$ (b) $\rho_C > \rho_A > \rho_T$

(c) $\rho_A > \rho_M > \rho_C$ (d) $\rho_A > \rho_T > \rho_C$

2. The current I_1 (in A) flowing through 1Ω resistor in the following circuit is



(a) 0.4 (b) 0.25

(c) 0.2 (d) 0.5

3. In a building there are 15 bulbs of 45 W, 15 bulbs of 100 W, 15 small fans of 10 W and 2 heaters of 1 kW. The voltage of electric main is 220 V. The minimum fuse capacity (rated values) of the building will be

(a) 25 A (b) 15 A

(c) 10 A (d) 20 A

4. A battery of 3.0 V is connected to a resistor dissipating 0.5 W of power. If the terminal voltage of the battery is 2.5 V, the power dissipated within the internal resistance is

(a) 0.50 W (b) 0.125 W

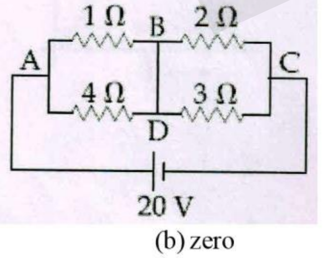
(c) 0.072 W (d) 0.10 W

5. Two resistors 400Ω and 800Ω are connected in series across a 6 V battery. The potential difference measured by a voltmeter of $10\,k\Omega$ across 400Ω resistor is close to

(a) 2 V (b) 1.95 V

(c) 2.05 V (d) 1.8 V

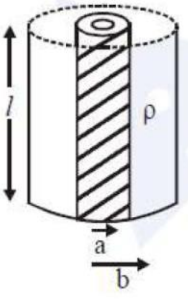
6. In the given circuit diagram, a wire is joining points B and D. The current in this wire is



(a) 0.4A (b) zero

(c) 2A (d) 4A

7. Model a torch battery of length l to be made up of a thin cylindrical bar of radius 'a' and a concentric thin cylindrical shell of radius 'b' filled in between with an electrolyte of resistivity r (see figure). If the battery is connected to a resistance of value R, the maximum Joule heating in R will take place for



(a) $R = \frac{2\rho}{\pi l}\ln\left(\frac{b}{a}\right)$

(b) $R = \frac{\rho}{\pi l}\ln\left(\frac{b}{a}\right)$

(c) $R = \frac{\rho}{2\pi l}\left(\frac{b}{a}\right)$

(d) $R = \frac{\rho}{2\pi l}\ln\left(\frac{b}{a}\right)$

8. A circuit to verify Ohm's law uses ammeter and voltmeter in series or parallel connected correctly to the resistor. In the circuit

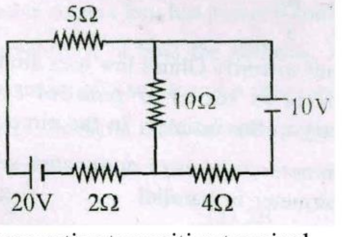
(a) ammeter is always connected series and voltmeter in parallel.

(b) Both, ammeter and voltmeter must be connected in series.

(c) Both ammeter and voltmeter must be connected in parallel.

(d) ammeter is always used in parallel and voltmeter is series.

9. In the figure shown, the current in the 10V battery is close to



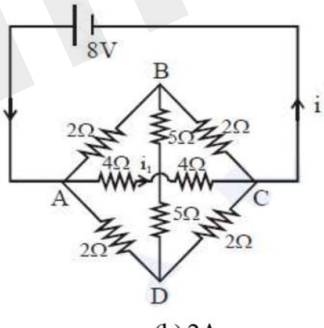
(a) 0.36 A from negative to positive terminal.

(b) 0.71 A from positive to negative terminal.

(c) 0.21 A from positive to negative terminal.

(d) 0.42 A from positive to negative terminal.

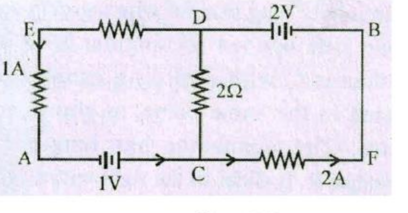
10. The value of current i_1 flowing from A to C in the circuit diagram is



(a) 5A (b) 2A

(c) 4A (d) 1A

11. In the circuit, given in the figure currents in different branches and value of one resistor are shown. Then potential at point B with respect to the point A is



(a) +1V (b) – 1V

(c) – 2V (d) +2V

12. A galvanometer having a coil resistance 100Ω gives a full scale deflection when a current of 1 mA is passed through it. What is the value of the resistance which can convert this galvanometer into a voltmeter giving full scale deflection for a potential difference of 10 V?

(a) 8.9 kΩ (b) 10 kΩ

(c) 9.9 kΩ (d) 7.9 kΩ

SOLUTION

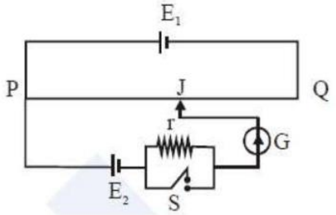
13. A galvanometer of resistance G is converted into a voltmeter of range 0–1V by connecting a resistance R_1 in series with it. The additional resistance that should be connected in series with R_1 to increase the range of the voltmeter to $0-2$V will be

(a) R_1 (b) R_1+G
(c) R_1-G (d) G

14. The length of a potentiometer wire is 1200 cm and it carries a current of 60 mA. For a cell of emf 5V and internal resistance of 20Ω, the null point on it is found to be at 1000 cm. The resistance of whole wire is

(a) 120Ω (b) 80Ω
(c) 60Ω (d) 100Ω

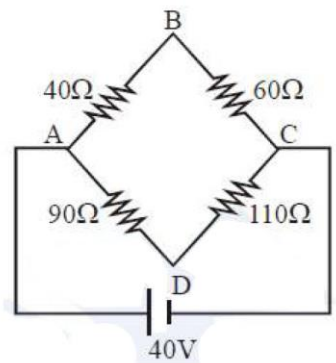
15. A potentiometer wire PQ of 1 m length is connected to a standard cell E_1. Another cell E_2 of emf 1.02 V is connected with a resistance 'r' and switch S (as shown in figure). With switch S open, the null position is obtained at a distance of 49 cm from Q. The potential gradient in the potentiometer wire is



(a) 0.02 V/cm (b) 0.04 V/cm
(c) 0.01 V/cm (d) 0.03 V/cm

16. Four resistances of 15Ω, 12Ω, 4Ω and 10Ω respectively in cyclic order form Wheatstone's network. The resistance that is to be connected in parallel with the resistance of 10Ω to balance the network is ______ Ω.

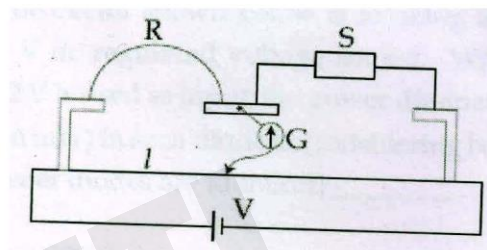
17. Four resistances 40 Ω, 60 Ω, 90 Ω and 110 Ω make the arms of a quadrilateral $ABCD$. Across AC is a battery of emf 40V and internal resistance negligible. The potential difference across BD in V is____.



18. The series combination of two batteries, both of the same emf 10 V, but different internal resistance of 20 Ω and 5 Ω, is connected to the parallel combination of two resistors 30 Ω and R Ω. The voltage difference across the battery of internal resistance 20 Ω is zero. The value of R(in Ω) is

19. The balancing length for a cell is 560 cm in a potentiometer experiment. When an external resistance of 10 Ω is connected in parallel to the cell, the balancing length changes by 60 cm. If the internal resistance of the cell is $(N/10)$ Ω, where N is an integer, then value of N is

20. In a meter bridge experiment, S is a standard resistance. R is a resistance wire. It is found that balancing length is $l=$ 25 cm. If R is replaced by a wire of half length and half diameter that of R of same material, then the balancing distance l' (in cm) will now be



SOLUTION

ANSWER KEY

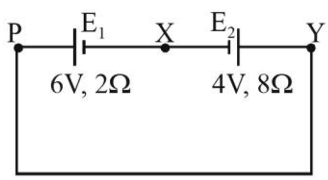
1. a
2. c
3. d
4. d
5. b
6. c
7. d
8. a
9. c
10. d
11. a
12. c
13. b
14. d
15. a
16. 10
17. 2
18. 30
19. 12
20. 40

Feb Attempt

1. A cylindrical wire of radius 0.5 mm and conductivity 5×10^7 S/m is subjected to an electric field of 10 mV/m. The expected value of current in the wire will be $x^3\pi$ mA. The value of x is ____.

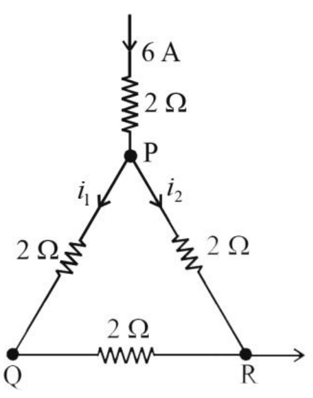
2. A current through a wire depends on time as $i = \alpha_0 t + \beta t^2$ where $\alpha_0 = 20$ A/s and $\beta = 8$ As^{-2}. Find the charge crossed through a section of the wire in 15 s.
(1) 2250 C (2) 11250 C
(3) 2100 C (4) 260 C

3. A cell E_1 of emf 6V and internal resistance 2Ω is connected with another cell E_2 of emf 4V and internal resistance 8Ω (as shown in the figure). The potential difference across points X and Y is :



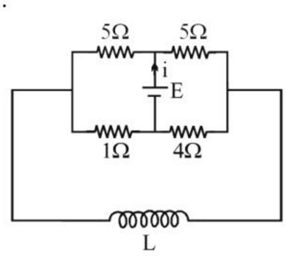
(1) 10.0 V (2) 3.6 V
(3) 5.6V (4) 2.0 V

4. A current of 6 A enters one corner P of an equilateral triangle PQR having 3 wires of resistance 2Ω each and leaves by the corner R. The currents i_1 in ampere is __________.



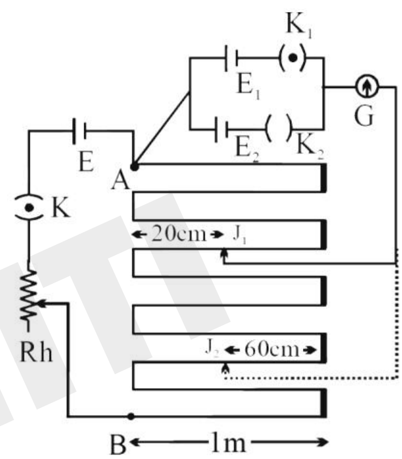
5. The current (i) at time t = 0 and t = ∞ respectively for the given circuit is :

(1) $\frac{18E}{55}, \frac{5E}{18}$ (2) $\frac{10E}{33}, \frac{5E}{18}$
(3) $\frac{5E}{18}, \frac{18E}{55}$ (4) $\frac{5E}{18}, \frac{10E}{33}$



6. In the given circuit of potentiometer, the potential difference E across AB (10m length) is larger than E_1 and E_2 as well. For key K_1 (closed), the jockey is adjusted to touch the wire at point J_1 so that there is no deflection in the galvanometer. Now the first battery (E_1) is replaced by second battery (E_2) for working by making K_1 open and K_2 closed. The galvanometer gives then null deflection at J_2.

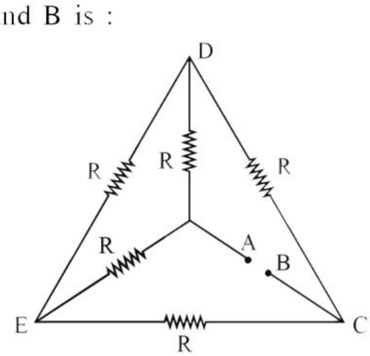
The value of $\frac{E_1}{E_2}$ is $\frac{a}{b}$, where a = ___.



7. A wire of 1Ω has a length of 1m. It is stetched till its length increases by 25%. The percentage change in resistance to the neartest integer is:-
(1) 56% (2) 25%
(3) 12.5% (4) 76%

8. Five equal resistances are connected in a network as shown in figure. The net resistance between the points A and B is :

(1) 2R (2) $\frac{R}{2}$
(3) $\frac{3R}{2}$ (4) R

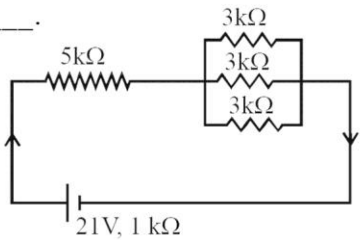


SOLUTION

March Attempt

1. A conducting wire of length 'l', area of cross-section A and electric resistivity ρ is connected between the terminals of a battery. A potential difference V is developed between its ends, causing an electric current.
If the length of the wire of the same material is doubled and the area of cross-section is halved, the resultant current would be :
(1) $\frac{1}{4}\frac{VA}{\rho l}$ (2) $\frac{3}{4}\frac{VA}{\rho l}$
(3) $\frac{1}{4}\frac{\rho l}{VA}$ (4) $4\frac{VA}{\rho l}$

2. In the figure given, the electric current flowing through the 5 kΩ resistor is 'x' mA.
The value of x to the nearest integer is ________.



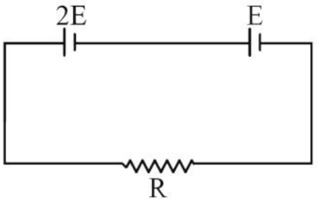
3. A resistor develops 500 J of thermal energy in 20s when a current of 1.5 A is passed through it. If the current is increased from 1.5 A to 3A, what will be the energy developed in 20 s.
(1) 1500 J (2) 1000 J
(3) 500 J (4) 2000 J

4. The energy dissipated by a resistor is 10 mJ in 1s when an electric current of 2 mA flows through it. The resistance is _______ Ω. (Round off to the Nearest Integer)

5. A current of 10A exists in a wire of crosssectional area of 5 mm^2 with a drift velocity of 2×10^{-3} ms^{-1}. The number of free electrons in each cubic meter of the wire is ___.
(1) 2×10^6 (2) 625×10^{25}
(3) 2×10^{25} (4) 1×10^{23}

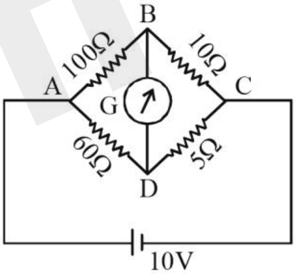
6. The equivalent resistance of series combination of two resistors is 's'. When they are connected in parallel, the equivalent resistance is 'p'. If s = np, then the minimum value for n is ___. (Round off to the Nearest Integer)

7. Two cells of emf 2E and E with internal resistance r_1 and r_2 respectively are connected in series to an external resistor R (see figure). The value of R, at which the potential difference across the terminals of the first cell becomes zero is

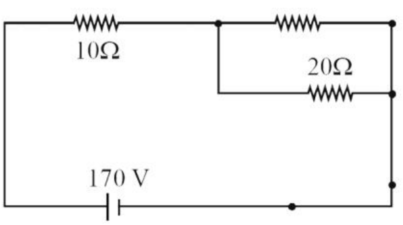


(1) $r_1 + r_2$ (2) $\frac{r_1}{2} - r_2$
(3) $\frac{r_1}{2} + r_2$ (4) $r_1 - r_2$

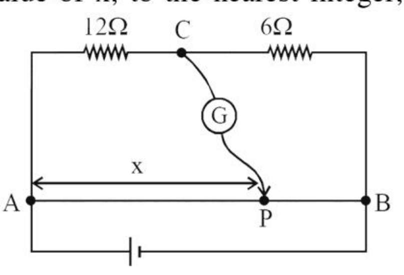
8. The four arms of a Wheatstone bridge have resistances as shown in the figure. A galvanometer of 15 Ω resistance is connected across BD. Calculate the current through the galvanometer when a potential difference of 10V is maintained across AC.
(1) 2.44 μA (2) 2.44 mA
(3) 4.87 mA (4) 4.87 μA



9. The voltage across the 10Ω resistor in the given circuit is x volt.
The value of 'x' to the nearest integer is _____.



10. Consider a 72 cm long wire AB as shown in the figure. The galvanometer jockey is placed at P on AB at a distance x cm from A. The galvanometer shows zero deflection.
The value of x, to the nearest integer, is

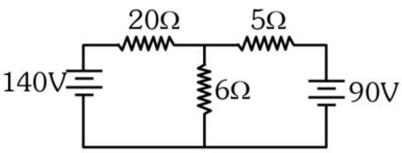


SOLUTION

11. Two wires of same length and thickness having specific resistances 6Ω cm and 3Ω cm respectively are connected in parallel. The effective resistivity is $\rho\ \Omega$ cm. The value of ρ, to the nearest integer, is_____.

July Attempt

1.



The value of current in the 6Ω resistance is :

(1) 4A (2) 8A (3) 10A (4) 6A

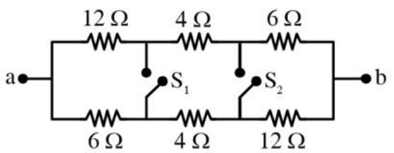
2. A current of 5 A is passing through a non-linear magnesium wire of cross-section $0.04\ m^2$. At every point the direction of current density is at an angle of 60° with the unit vector of area of cross-section. The magnitude of electric field at every point of the conductor is :

(Resistivity of magnesium $\rho = 44 \times 10^{-8}\ \Omega m$)

(1) 11×10^{-2} V/m (2) 11×10^{-7} V/m

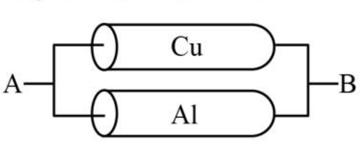
(3) 11×10^{-5} V/m (4) 11×10^{-3} V/m

3. In the given figure switches S_1 and S_2 are in open condition. The resistance across ab when the switches S_1 and S_2 are closed is _________Ω.



4. A Copper (Cu) rod of length 25 cm and cross-sectional area 3 mm^2 is joined with a similar Aluminium (Al) rod as shown in figure. Find the resistance of the combination between the ends A and B.

(Take Resistivity of Copper = $1.7 \times 10^{-8}\Omega m$ Resistivity of Aluminium = $2.6 \times 10^{-8}\ \Omega m$)



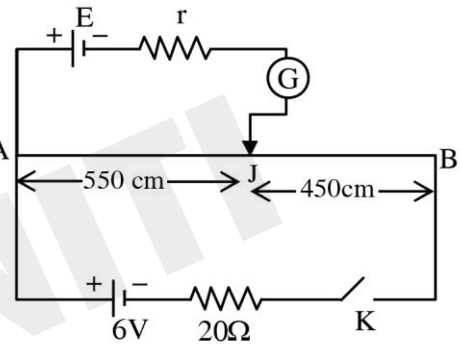
(1) 2.170 mΩ (2) 1.420 mΩ

(3) 0.0858 mΩ (4) 0.858 mΩ

SOLUTION

5. In an electric circuit, a call of certain emf provides a potential difference of 1.25 V across a load resistance of 5 Ω. However, it provides a potential difference of 1 V across a load resistance of 2Ω. The emf of the cell is given by $\frac{x}{10}$ V. Then the value of x is ________.

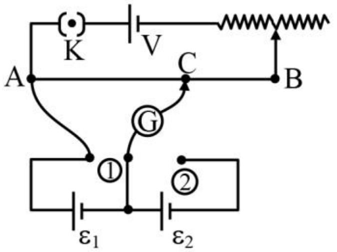
6. In the given figure, there is a circuit of potentiometer of length AB = 10 m. The resistance per unit length is 0.1 Ω per cm. Across AB, a battery of emf E and internal resistance 'r' is connected. The maximum value of emf measured by this potentiometer is :



(1) 5 V (2) 2.25 V (3) 6 V (4) 2.75 V

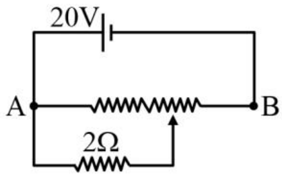
7. An electric bulb rated as 200 W at 100 V is used in a circuit having 200 V supply. The resistance 'R' that must be put in series with the bulb so that the bulb delivers the same power is _____ Ω.

8. In the given potentiometer circuit arrangement, the balancing length AC is measured to be 250 cm. When the galvanometer connection is shifted from point (1) to point (2) in the given diagram, the balancing length becomes 400 cm. The ratio of the emf of two cells, $\frac{\varepsilon_1}{\varepsilon_2}$ is :



(1) $\frac{5}{3}$ (2) $\frac{8}{5}$ (3) $\frac{4}{3}$ (4) $\frac{3}{2}$

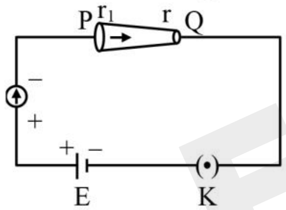
9. The given potentiometer has its wire of resistance 10Ω. When the sliding contact is in the middle of the potentiometer wire, the potential drop across 2Ω resistor is :



(1) 10 V (2) 5 V (3) $\frac{40}{9}$ V (4) $\frac{40}{11}$ V

10. A 16 Ω wire is bend to form a square loop. A 9V supply having internal resistance of 1 Ω is connected across one of its sides. The potential drop across the diagonals of the square loop is _________ $\times 10^{-1}$ V

11. In the given figure, a battery of emf E is connected across a conductor PQ of length 'l' and different area of cross-sections having radii r_1 and r_2 ($r_2 < r_1$).



Choose the correct option as one moves from P to Q :
(1) Drift velocity of electron increases.
(2) Electric field decreases.
(3) Electron current decreases.
(4) All of these

12. The resistance of a conductor at 15°C is 16 Ω and at 100°C is 20Ω. What will be the temperature coefficient of resistance of the conductor?
(1) $0.010°C^{-1}$ (2) $0.033°C^{-1}$
(3) $0.003°C^{-1}$ (4) $0.042°C^{-1}$

13. For the circuit shown, the value of current at time t = 3.2 s will be ______ A.

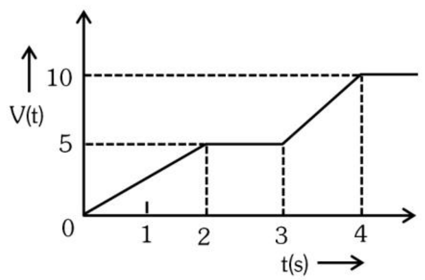


Figure 1

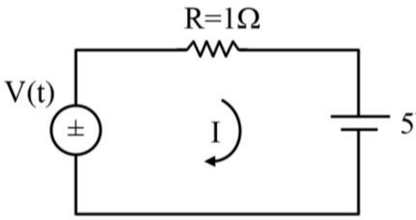
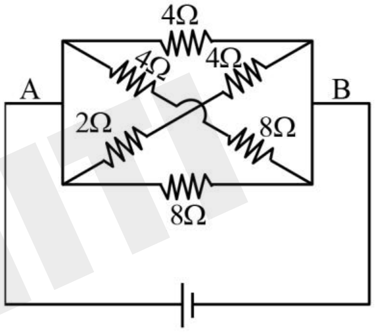


Figure-2

[Voltage distribution V(t) is shown by Fig. (1) and the circuit is shown in Fig. (2)]

August Attempt

1. In the given figure, the emf of the cell is 2.2 V and if internal resistance is 0.6Ω. Calculate the power dissipated in the whole circuit :



2.2 V, r=0.6Ω

(1) 1.32 W (2) 0.65 W
(3) 2.2 W (4) 4.4 W

2. What equal length of an iron wire and a copper-nickel alloy wire, each of 2 mm diameter connected parallel to give an equivalent resistance of 3Ω?
(Given resistivities of iron and copper-nickel alloy wire are 12 μΩ cm and 51 μΩ cm respectively)
(1) 82 m (2) 97 m
(3) 110 m (4) 90 m

3. If you are provided a set of resistances 2Ω, 4Ω, 6Ω and 8Ω. Connect these resistances so as to obtain an equivalent resistance of $\frac{46}{3}$Ω.
(1) 4Ω and 6Ω are in parallel with 2Ω and 8 Ω in series
(2) 6Ω and 8Ω are in parallel with 2Ω and 4Ω in series
(3) 2Ω and 6Ω are in parallel with 4Ω and 8 Ω in series
(4) 2Ω and 4Ω are in parallel with 6Ω and 8Ω in series

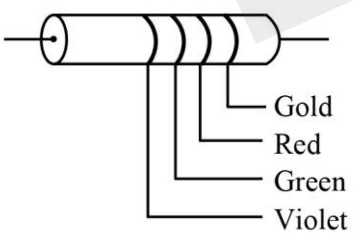
SOLUTION

4. An electric bulb of 500 watt at 100 volt is used in a circuit having a 200 V supply. Calculate the resistance R to be connected in series with the bulb so that the power delivered by the bulb is 500 W.
(1) 20 Ω (2) 30 Ω (3) 5 Ω (4) 10 Ω

5. Five identical cells each of internal resistance 1Ω and emf 5V are connected in series and in parallel with an external resistance 'R'. For what value of 'R', current in series and parallel combination will remain the same ?
(1) 1 Ω (2) 25 Ω
(3) 5 Ω (4) 10 Ω

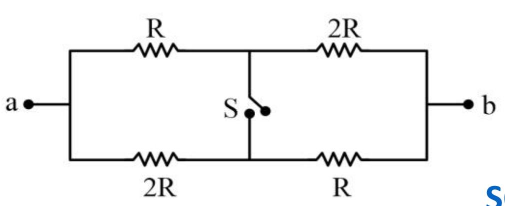
6. First, a set of n equal resistors of 10 Ω each are connected in series to a battery of emf 20V and internal resistance 10 Ω. A current I is observed to flow. Then, the n resistors are connected in parallel to the same battery. It is observed that the current is increased 20 times, then the value of n is ....

7. The colour coding on a carbon resistor is shown in the given figure. The resistance value of the given resistor is :



(1) (5700 ± 285) Ω (2) (7500 ± 750) Ω
(3) (5700 ± 375) Ω (4) (7500 ± 375) Ω

8. The ratio of the equivalent resistance of the network (shown in figure) between the points a and b when switch is open and switch is closed is x : 8. The value of x is ________.

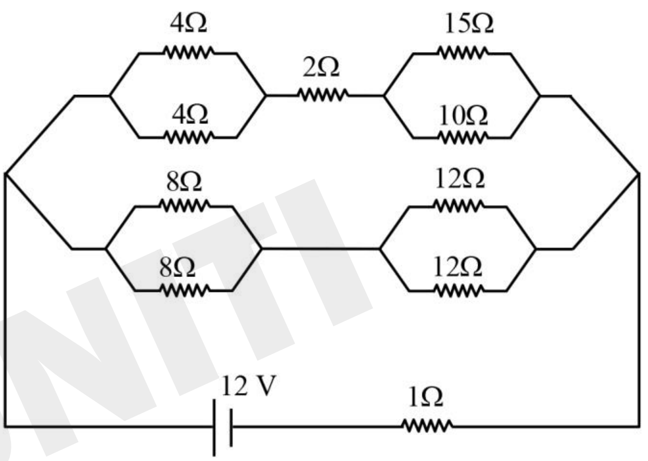


SOLUTION

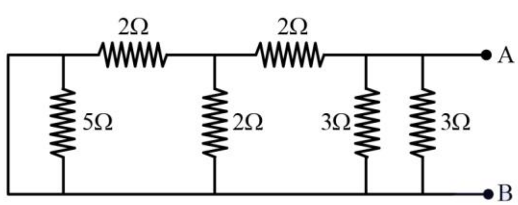
9. Consider a galvanometer shunted with 5Ω resistance and 2% of current passes through it. What is the resistance of the given galvanometer ?
(1) 300 Ω (2) 344 Ω
(3) 245 Ω (4) 226 Ω

10. A square shaped wire with resistance of each side 3Ω is bent to form a complete circle. The resistance between two diametrically opposite points of the circle in unit of Ω will be _______.

11. The voltage drop across 15Ω resistance in the given figure will be_______V.



12 The equivalent resistance of the given circuit between the terminals A and B is :



(1) 0Ω (2) 3Ω (3) $\frac{9}{2}$Ω (4) 1Ω

13. A resistor dissipates 192 J of energy in 1 s when a current of 4A is passed through it. Now, when the current is doubled, the amount of thermal energy dissipated in 5 s in______J.

14. A uniform heating wire of resistance 36 Ω is connected across a potential difference of 240 V. The wire is then cut into half and potential difference of 240 V is applied across each half separately. The ratio of power dissipation in first case to the total power dissipation in the second case would be 1 : x, where x is...........

ANSWER KEY

Feb Attempt

1. 5
2. 2
3. 3
4. 2
5. 4
6. 1
7. 1
8. 4

March Attempt

1. 1
2. 3
3. 4
4. 2500
5. 2
6. 4
7. 2
8. 3
9. 70
10. 48
11. 4

July Attempt

1. 3
2. 3
3. 10
4. 4
5. 15
6. 5
7. 50
8. 1
9. 3
10. 45
11. 1
12. 3
13. 1

August Attempt

1. 3
2. 2
3. 4
4. 1
5. 1
6. 20
7. 4
8. 9
9. 3
10. 3
11. 6
12. 4
13. 3840
14. 4

1. Two identical cells each of emf 1.5 V are connected in parallel across a parallel combination of two resistors each of resistance 20Ω. A voltmeter connected in the circuit measures 1.2 V. The internal resistance of each cell is

(A) 2.5Ω (B) 4Ω
(C) 5Ω (D) 10Ω

2. In a potentiometer arrangement, a cell gives a balancing point at 75 cm length of wire. This cell is now replaced by another cell of unknown emf. If the ratio of the emf's of two cells respectively is 3 : 2, the difference in the balancing length of the potentiometer wire in above two cases will be ______ cm.

3. What will be the most suitable combination of three resistors A = 2Ω, B = 4Ω, C = 6 Ω so that $\left(\frac{22}{3}\right)\Omega$ is equivalent resistance of combination?

(A) Parallel combination of A and C connected in series with B.
(B) Parallel combination of A and B connected in series with C.
(C) Series combination of A and C connected in parallel with B.
(D) Series combination of B and C connected in parallel with A.

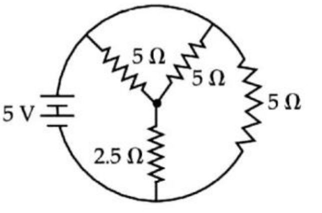
4. A potentiometer wire of length 10 m and resistance 20 Ω is connected in series with a 25 V battery and an external resistance 30 Ω. A cell of emf E in secondary circuit is balanced by 250 cm long potentiometer wire. The value of E (in volt) is $\frac{x}{10}$. The value of x is _______.

5. A teacher in his physics laboratory allotted an experiment to determine the resistance (G) of a galvanometer. Students took the observations for $\frac{1}{3}$ deflection in the galvanometer. Which of the below is **true** for measuring value of G?

(A) $\frac{1}{3}$ deflection method cannot be used for determining the resistance of the galvanometer.
(B) $\frac{1}{3}$ deflection method can be used and in this case the G equals to twice the value of shunt resistance(s).
(C) $\frac{1}{3}$ deflection method can be used and in this case, the G equals to three times the value of shunt resistance(s)
(D) $\frac{1}{3}$ deflection method can be used and in this case the G value equals to the shunt resistance(s).

6. A resistor develops 300 J of thermal energy in 15s, when a current of 2A is passed through it. If the current increases to 3A, the energy developed in 10s is _________ J.

7. The total current supplied to the circuit as shown in figure by the 5V battery is __________A



8. Two cells of same emf but different internal resistances r_1 and r_2 are connected in series with a resistance R. The value of resistance R, for which the potential difference across second cell is zero, is

(A) $r_2 - r_1$ (B) $r_1 - r_2$
(C) r_1 (D) r_2

SOLUTION

9. If n represents the actual number of deflections in a converted galvanometer of resistance G and shunt resistance S. Then the total current I when its figure of merit is K will be :

(A) $\frac{KS}{(S+G)}$ (B) $\frac{(G+S)}{nKS}$

(C) $\frac{nKS}{(G+S)}$ (D) $\frac{nK(G+S)}{S}$

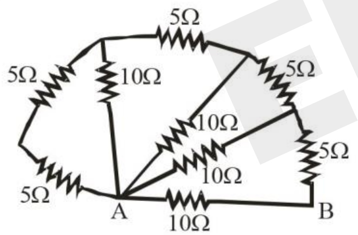
10. The length of a given cylindrical wire is increased to double of its original length. The percentage increase in the resistance of the wire will be ____%.

11. An aluminium wire is stretched to make its length, 04% larger. Then percentage change in resistance is:

(A) 0.4 % (B) 0.2 %

(C) 0.8 % (D) 0.6 %

12. The equivalent resistance between points A and B in the given network is :



(A) 65Ω (B) 20Ω

(C) 5Ω (D) 2Ω

13. A 72 Ω galvanometer is shunted by a resistance of 8 Ω. The percentage of the total current which passes through the galvanometer is :

(A) 0.1% (B) 10 %

(C) 25% (D) 0.25%

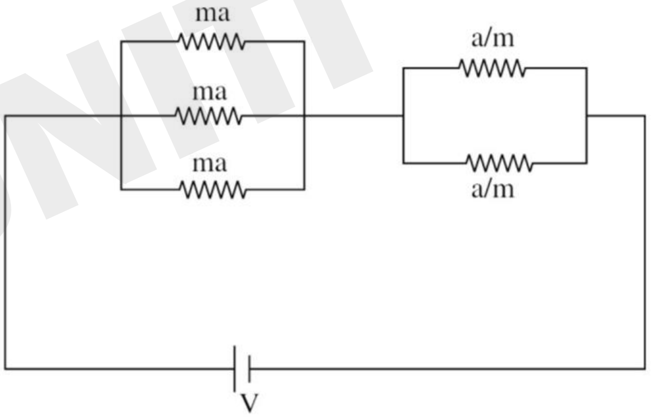
14. A cell, shunted by a 8 Ω resistance, is balanced across a potentiometer wire of length 3m. The balancing length is 2 m when the cell is shunted by 4Ω resistance. The value of internal resistance of the cell will be _____ Ω.

SOLUTION

15. The current density in a cylindrical wire of radius 4 mm is $4\times10^{6}\,Am^{-2}$. The current through the outer portion of the wire between radial distance $\frac{R}{2}$ and R is ____ π A.

16. The current density in a cylindrical wire of radius r = 4.0 mm is 1.0×10^{6} A/m^2. The current through the outer portion of the wire between radial distances r/2 and r is xπ A; where x is _______ .

17. In the given circuit 'a' is an arbitrary constant. The value of m for which the equivalent circuit resistance is minimum, will be $\sqrt{\frac{x}{2}}$. The value of x is _____ .



18. For using a multimeter to identify diode from electrical components. choose the correct statement out of the following about the diode :

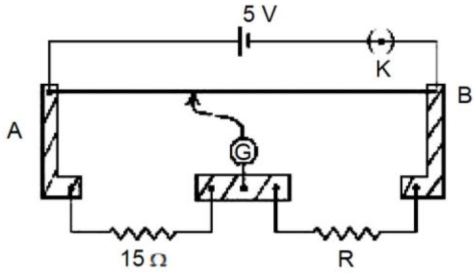
(A) It is two terminal device which conducts current in both directions.

(B) It is two terminal device which conducts current in one direction only

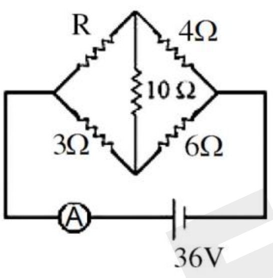
(C) It does not conduct current gives an initial deflection which decays to zero.

(D) It is three terminal device which conducts current in ne direction only between central terminal and either of the remaining two terminals

19. A meter bridge setup is shown in the figure. It is used to determine an unknown resistance R using a given resistor of 1 5 Ω. The galvanometer (G) shows null deflection when tapping key is at 43 cm mark from end A. If the end correction for end A is 2 cm. then the determined value of R will be _______ Ω.



20. Current measured by the ammeter (A) in the reported circuit when no current flows through 10 Ω resistance. will be _________ A.

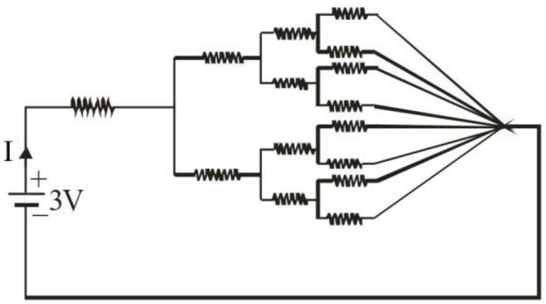


21. Resistance of the wire is measured as 2Ω and 3Ω at 10°C and 30°C respectively. Temperature co–coefficient of resistance of the material of the wire is :

(A) $0.033°C^{-1}$ (B) $-0.033°C^{-1}$

(C) $0.011°C^{-1}$ (D) $0.055°C^{-1}$

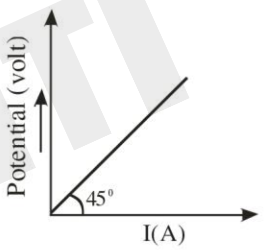
22. All resistances in figure are 1Ω each. The value of current 'I' is $\frac{a}{5}$ A . The value of a is ______



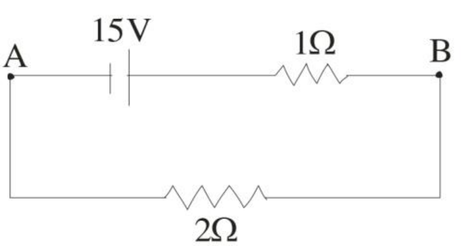
23. Two coils require 20 minutes and 60 minutes respectively to produce same amount of heat energy when connected separately to the same source. If they are connected in parallel arrangement to the same source; the time required to produce same amount of heat by the combination of coils, will be__________min.

24. The variation of applied potential and current flowing through a given wire is shown in figure. The length of wire is 31.4 cm. The diameter of wire is measured as 2.4 cm. The resistivity of the given wire is measured as $x \times 10^{-3}$ Ω cm. The value of x is __________.

[Take π = 3.14]



25. For the network shown below, the value $V_B - V_A$ is ________V.



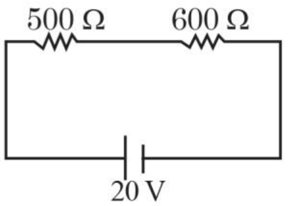
26. The combination of two identical cells, whether connected in series or parallel combination provides the same current through an external resistance of 2Ω. The value of internal resistance of each cell is :

(A) 2Ω (B) 4Ω

(C) 6Ω (D) 8Ω

SOLUTION

27. Two resistors are connected in series across a battery as shown in figure. If a voltmeter of resistance 2000 Ω is used to measure the potential difference across 500 Ω resister, the reading of the voltmeter will be____V.

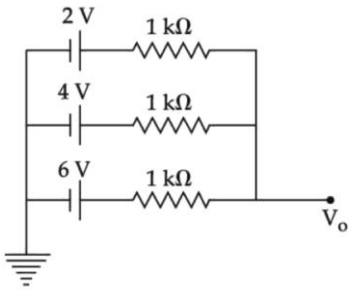


SOLUTION

Answer Key

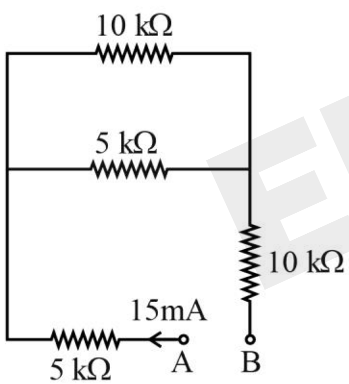
1. C
2. 25
3. B
4. 25
5. B
6. 450
7. 2
8. A
9. D
10. 300
11. C
12. C
13. B
14. 8
15. 48
16. 12
17. 3
18. B
19. 19
20. 10
21. A
22. 8
23. 15
24. 144
25. 10
26. A
27. 8

1. In the given figure, the value of V_0 will be ____ V.



2. Eight copper wire of length l and diameter d are joined in parallel to form a single composite conductor of resistance R. If a single copper wire of length $2l$ have the same resistance (R) then its diameter will be _________ d.

3. A current of 15 mA flows in the circuit as shown in figure. The value of potential difference between the points A and B will be

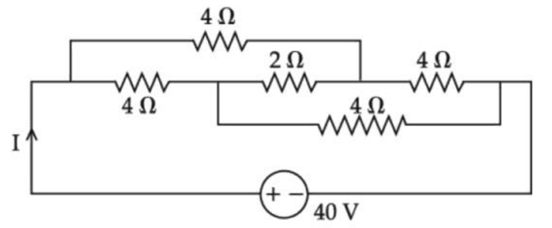


(A) 50V (B) 75V

(C) 150V (D) 275V

4. In a potentiometer arrangement, a cell of emf 1.20 V gives a balance point at 36 cm length of wire. This cell is now replaced by another cell of emf 1.80 V. The difference in balancing length of potentiometer wire in above conditions will be _________ cm.

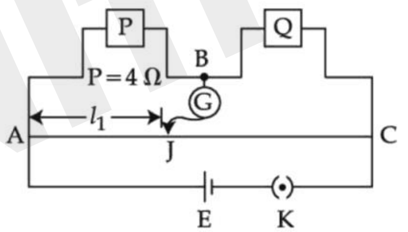
5. The current I in the given circuit will be :



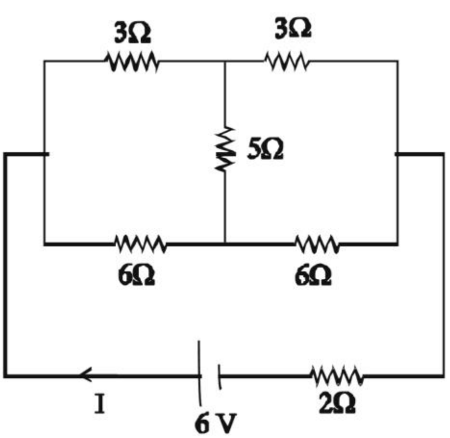
(A) 10A (B) 20 A

(C) 4A (D) 40A

6. Resistance are connected in a meter bridge circuit as shown in the figure. The balancing length l_1 is 40cm. Now an unknown resistance x is connected in series with P and new balancing length is found to be 80cm measured from the same end. Then the value of x will be _____ Ω



7. A battery of 6 V is connected to the circuit as shown below. The current I drawn from the battery is :



(A) 1A (B) 2A

(C) $\frac{6}{11}$A (D) $\frac{4}{3}$A

SOLUTION

8. A potentiometer wire of length 300 cm is connected in series with a resistance 780 Ω and a standard cell of emf 4V. A constant current flows through potentiometer wire. The length of the null point for cell of emf 20 mV is found to be 60 cm. The resistance of the potentiometer wire is____Ω.

9. Two sources of equal emfs are connected in series. This combination is connected to an external resistance R. The internal resistances of the two sources are r_1 and r_2 ($r_1 > r_2$). If the potential difference across the source of internal resistance r_1 is zero then the value of R will be

(A) $r_1 - r_2$ (B) $\frac{r_1 r_2}{r_1 + r_2}$

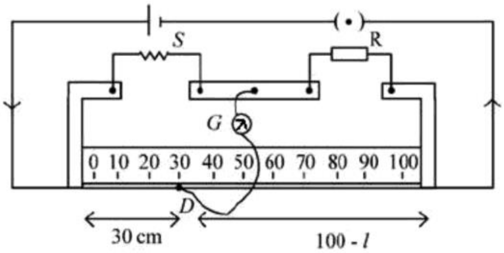
(C) $\frac{r_1 + r_2}{2}$ (D) $r_2 - r_1$

10. A direct current of 4 A and an alternating current of peak value 4 A flow through resistance of 3 Ω and 2 Ω respectively. The ratio of heat produced in the two resistances in same interval of time will be :

(A) 3 : 2 (B) 3 : 1

(C) 3 : 4 (D) 4 : 3

11. In meter bridge experiment for measuring unknown resistance 'S', the null point is obtained at a distance 30 cm from the left side as shown at point D. If R is 5.6 kΩ, then the value of unknown resistance 'S' will be _______ Ω.



12. A. The drift velocity of electrons decreases with the increase in the temperature of conductor.

B. The drift velocity is inversely proportional to the area of cross-section of given conductor.

C. The drift velocity does not depend on the applied potential difference to the conductor.

D. The drift velocity of electron is inversely proportional to the length of the conductor.

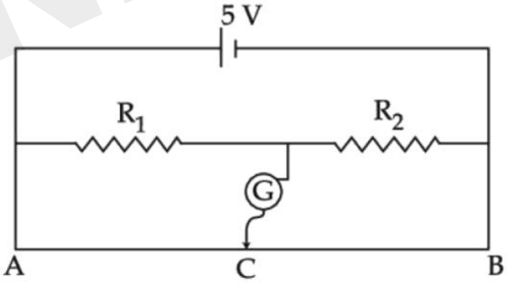
E. The drift velocity increases with the increase in the temperature of conductor.

Choose the correct answer from the options given below:

(A) A and B only (B) A and D only

(C) B and E only (D) B and C only

13. In the given figure of meter bridge experiment, the balancing length AC corresponding to null deflection of the galvanometer is 40 cm. The balancing length, if the radius of the wire AB is doubled, will be……….cm.



14. A wire of resistance R_1 is drawn out so that its length is increased by twice of its original length. The ratio of new resistance to original resistance is:

(A) 9 : 1 (B) 1 : 9

(C) 4 : 1 (D) 3 : 1

SOLUTION

15. The current sensitivity of a galvanometer can be increased by :

(A) decreasing the number of turns

(B) increasing the magnetic field

(C) decreasing the area of the coil

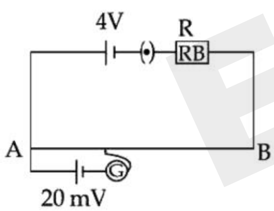
(D) decreasing the torsional constant of the spring

Choose the most appropriate answer from the options given below :

(A) (B) and (C) only (B) (C) and (D) only

(C) (A) and (C) only (D) (B) and (D) only

16. As shown in the figure, a potentiometer wire of resistance 20Ω and length 300 cm is connected with resistance box (R.B.) and a standard cell of emf 4 V. For a resistance 'R' of resistance box introduced into the circuit, the null point for a cell of 20 mV is found to be 60 cm. The value of 'R' is __________ Ω.



17. **Statement I :** A uniform wire of resistance 80Ω is cut into four equal parts. These parts are now connected in parallel. The equivalent resistance of the combination will be 5 Ω.

Statement II : Two resistance 2R and 3R are connected in parallel in a electric circuit. The value of thermal energy developed in 3R and 2R will be in the ratio 3 : 2.

In the light of the above statements, choose the most appropriate answer from the options given below

(A) Both statement I and statement II are correct

(B) Both statement I and statement II are incorrect

(C) Statement I is correct but statement II is incorrect

(D) Statement I is incorrect but statement II is correct.

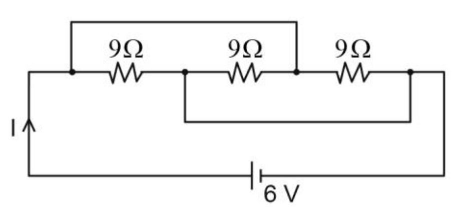
18. An electrical bulb rated 220 V, 100 W, is connected in series with another bulb rated 220 V, 60 W. If the voltage across combination is 220 V, the power consumed by the 100 W bulb will be about ………. W.

19. Two metallic wires of identical dimensions are connected is series. If σ_1 and σ_2 are the conductivities of the these wires respectively, the effective conductivity of the combination is :

(A) $\dfrac{\sigma_1 \sigma_2}{\sigma_1+\sigma_2}$ (B) $\dfrac{2\sigma_1 \sigma_2}{\sigma_1+\sigma_2}$

(C) $\dfrac{\sigma_1+\sigma_2}{2\sigma_1 \sigma_2}$ (D) $\dfrac{\sigma_1+\sigma_2}{\sigma_1 \sigma_2}$

20. The current I flowing through the given circuit will be __________ A.



SOLUTION

21. Given below are two statements: one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A: Alloys such as constantan and manganin are used in making standard resistance coils.

Reason R: Constantan and manganin have very small value of temperature coefficient of resistance.

In the light of the above statements, choose the correct answer from the options given below.

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is NOT the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

22. A 1 m long wire is broken into two unequal parts X and Y The X part of the wire is streched into another wire W. Length of W is twice the length of X and the resistance of W is twice that of Y. Find the ratio of length of X and Y.

(A) 1 : 4 (B) 1 : 2

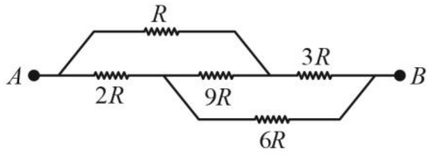
(C) 4 :1 (D) 2 : 1

SOLUTION

ANSWER KEY

1. 4
2. 4
3. D
4. 18
5. A
6. 20
7. A
8. 20
9. A
10. B
11. 2400
12. B
13. 40
14. A
15. D
16. 780
17. C
18. 14
19. B
20. 2
21. A
22. B

1. The equivalent resistance between A and B of the network shown in figure:



(1) $11\frac{2R}{3}$ (2) $14R$

(3) $21R$ (4) $\frac{8}{3}R$

2. In an experiment to find emf of a cell using potentiometer, the length of null point for a cell of emf 1.5 V is found to be 60 cm. If this cell is replaced by another cell of emf E, the length-of null point increases by 40 cm. The value of E is $\frac{x}{10}$ V. The value of x is __________.

3. Equivalent resistance between the adjacent corners of a regular n-sided polygon of uniform wire of resistance R would be:

(1) $\frac{(n-1)R}{n^2}$ (2) $\frac{(n-1)R}{(2n-1)}$

(3) $\frac{n^2R}{n-1}$ (4) $\frac{(n-1)R}{n}$

4. Given below are two statements : One is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : For measuring the potential difference across a resistance of 600 Ω, the voltmeter with resistance 1000 Ω will be preferred over voltmeter with resistance 4000 Ω.

Reason R : Voltmeter with higher resistance will draw smaller current than voltmeter with lower resistance.

In the light of the above statements, choose the **most appropriate** answer from the options given below.

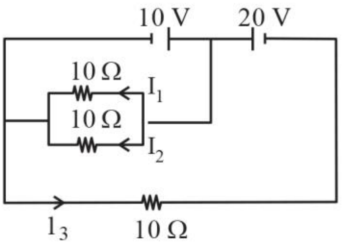
(1) **A** is not correct but **R** is correct

(2) Both **A** and **R** are correct and **R** is the correct explanation of **A**

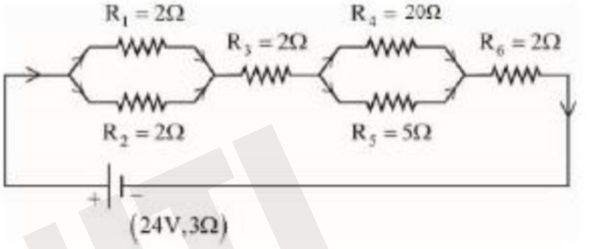
(3) Both **A** and **R** are correct but **R** is not the correct explanation of **A**

(4) **A** is correct but **R** is not correct

5. In the given circuit the value of $\left|\frac{I_1+I_3}{I_2}\right|$ is:



6. As shown in the figure, a network of resistors is connected to a battery of 24 V with an internal resistance of 3Ω. The currents through the resistors R_4 and R_5 are I_4 and I_5 respectively. The values of I_4 and I_5 are :



(1) $I_4 = \frac{8}{5}$A and $I_5 = \frac{2}{5}$A

(2) $I_4 = \frac{24}{5}$A and $I_5 = \frac{6}{5}$A

(3) $I_4 = \frac{6}{5}$A and $I_5 = \frac{24}{5}$A

(4) $I_4 = \frac{2}{5}$A and $I_5 = \frac{8}{5}$A

7. A hollow cylindrical conductor has length of 3.14 m, while its inner and outer diameters are 4 mm and 8 mm respectively. The resistance of the conductor is $n \times 10^{-3}$ Ω.
If the resistivity of the material is 2.4×10^{-8} Ωm. The value of n is _______ .

8. A cell of emf 90 V is connected across series combination of two resistors each of 100Ω resistance. A voltmeter of resistance 400 Ω is used to measure the potential difference across each resistor. The reading of the voltmeter will be :

(1) 40 V (2) 45 V

(3) 80 V (4) 90 V

SOLUTION

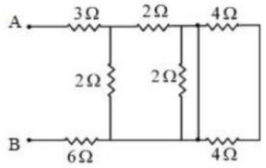
9. If a copper wire is stretched to increase its length by 20°%. The percentage increase in resistance of the wire is __________ %.

10. A uniform metallic wire carries a current 2 A. when 3.4 V battery is connected across it. The mass of uniform metallic wire is 8.92×10^{-3} kg. density is 8.92×10^{3} kg/m^{3} and resistivity is $1.7\times10^{-8}\ \Omega$–m. The length of wire is :

(1) l =6.8 m (2) l = 10 m

(3) l = 5 m (4) l = 100 m

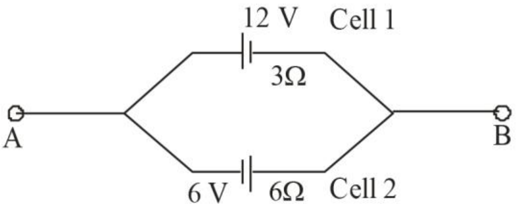
11. In the given circuit, the equivalent resistance between the terminal A and B is_____Ω.



12. The resistance of a wire is 5 Ω. It's new resistance in ohm if stretched to 5 times of it's original length will be :

(1) 625 (2) 5 (3) 125 (4) 25

13 Two cells are connected between points A and B as shown. Cell 1 has emf of 12 V and internal resistance of 3Ω. Cell 2 has emf of 6V and internal resistance of 6Ω. An external resistor R of 4Ω is connected across A and B. The current flowing through R will be ______ A.



14. Ratio of thermal energy released in two resistor R and 3R connected in parallel in an electric circuit is :

(1) 3 : 1 (2) 1 : 1

(3) 1 : 3 (4) 1 : 27

15. In a metre bridge experiment the balance point in obtained if the gaps are closed by 2Ω and 3Ω. A shunt of XΩ is added to 3Ω resistor to shift the balancing point by 22.5 cm. The value of X is ____

16. With the help of potentiometer, we can determine the value of emf of a given cell. The sensitivity of the potentiometer is

(A) directly proportional to the length of the potentiometer wire

(B) directly proportional to the potential gradient of the wire

(C) inversely proportional to the potential gradient of the wire

(D) inversely proportional to the length of the potentiometer wire

Choose the correct option for the above statements:

(1) B and D only (2) A and C only

(3) A only (4) C only

17. When two resistance R_1 and R_2 connected in series and introduced into the left gap of a meter bridge and a resistance of 10 Ω is introduced into the right gap, a null point is found at 60 cm from left side. When R_1 and R_2 are connected in parallel and introduced into the left gap, a resistance of 3 Ω is introduced into the right-gap to get null point at 40 cm from left end. The product of R_1 R_2 is _____ Ω^2

18. A null point is found at 200 cm in potentiometer when cell in secondary circuit is shunted by 5Ω. When a resistance of 15 Ω is used for shunting, null point moves to 300 cm. The internal resistance of the cell is ______Ω.

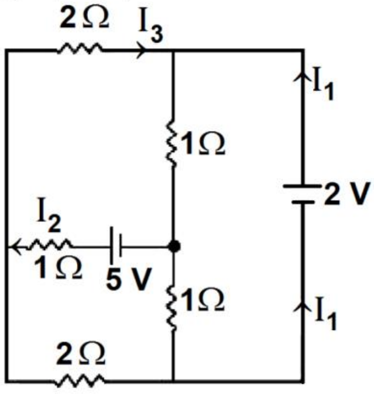
SOLUTION

19. The charge flowing in a conductor changes with time as $Q(t)=\alpha t-\beta t^2+\gamma t^3$. Where α,β and γ are constants. Minimum value of current is :

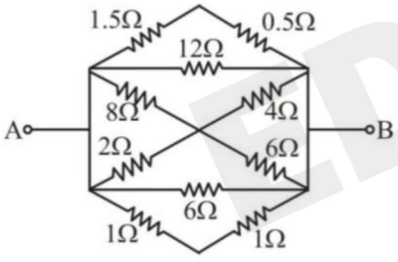
(1) $\alpha-\frac{3\beta^2}{\gamma}$ (2) $\alpha-\frac{\gamma^2}{3\beta}$

(3) $\beta-\frac{\alpha^2}{3\gamma}$ (4) $\alpha-\frac{\beta^2}{3\gamma}$

20. In the following circuit, the magnitude of current I_1, is _____ A.



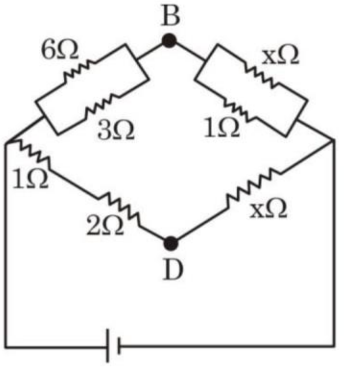
21. The equivalent resistance between A and B is ……



(1) $\frac{2}{3}\Omega$ (2) $\frac{1}{2}\Omega$

(3) $\frac{3}{2}\Omega$ (4) $\frac{1}{3}\Omega$

22. If the potential difference between B and D is zero, the value of x is $\frac{1}{n}\Omega$. The value of n is ……..



23. The drift velocity of electrons for a conductor connected in an electrical circuit is V_d. The conductor in now replaced by another conductor with same material and same length but double the area of cross section. The applied voltage remains same. The new drift velocity of electrons will be

(1) V_d (2) $\frac{V_d}{2}$

(3) $\frac{V_d}{4}$ (4) $2V_d$

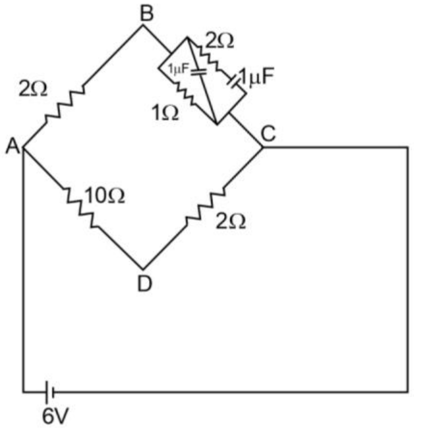
24. Two identical cells, when connected either in parallel or in series gives same current in an external resistance 5Ω. The internal resistance of each cell will be ________ Ω.

25. The H amount of thermal energy is developed by a resistor in 10 s when a current of 4A is passed through it. If the current is increased to 16A, the thermal energy developed by the resistor in 10 s will be:

(1) H (2) 16H

(3) $\frac{H}{4}$ (4) 4H

26. For the given circuit, in the steady state, $|V_B-V_D|$ = ________V.

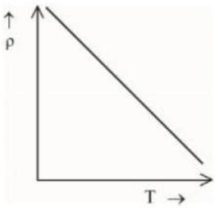


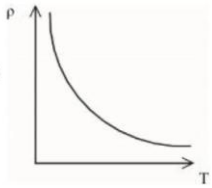
SOLUTION

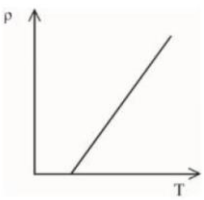
ANSWER KEY

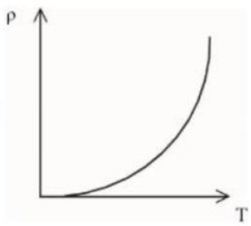
1. 4
2. 25
3. 1
4. 1
5. 2
6. 4
7. 2
8. 1
9. 44
10. 2
11. 10
12. 3
13. 1
14. 1
15. 2
16. 2
17. 30
18. 5
19. 4
20. 2
21. 1
22. 2
23. 1
24. 5
25. 2
26. 1

1. The resistivity (ρ) of semiconductor varies with temperature. Which of the following curve represents the correct behaviour

(1) 

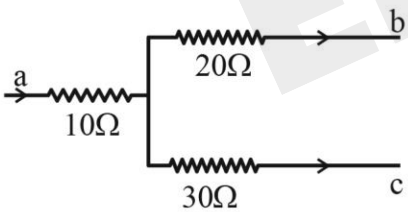
(2) 

(3) 

(4) 

2. The length of a metallic wire is increased by 20% and its area of cross section is reduced by 4%. The percentage change in resistance of the metallic wire is _______ .

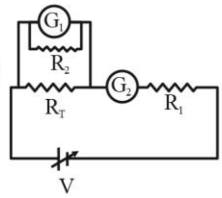
3. Figure shows a part of an electric circuit. The potentials at points a, b and c are 30 V, 12 V and 2V respectively. The current through the 20Ω resistor will be.

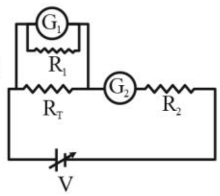


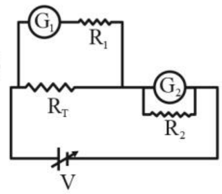
(1) 0.4 A (2) 0.2 A

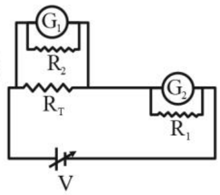
(3) 0.6 A (4) 1.0 A

4. A student is provided with a variable voltage source V, a test resistor $R_T = 10\Omega$, two identical galvanometers G_1 and G_2 and two additional resistors, $R_1 = 10M\Omega$ and $R_2 = 0.001\Omega$. For conducting an experiment to verify ohm's law, the most suitable circuit is:

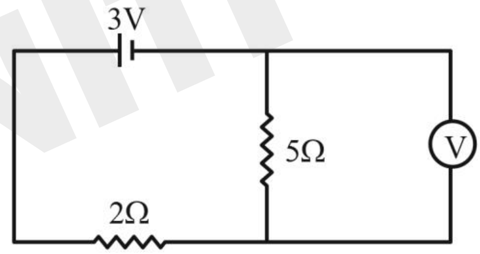
(1) 

(2) 

(3) 

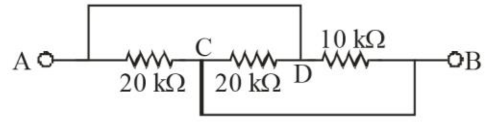
(4) 

5. As shown in the figure, the voltmeter reads 2V across 5 Ω resistor. The resistance of the voltmeter is________Ω.



6. A current of 2 A flows through a wire of cross-sectional area 25.0 mm^2. The number of free electrons in a cubic meter are 2.0×10^{28}. The drift velocity of the electrons is _____ $\times10^{-6}ms^{-1}$ (given, charge on electron $=1.6\times10^{-19}C$)

7. The equivalent resistance between A and B as shown in figure is:



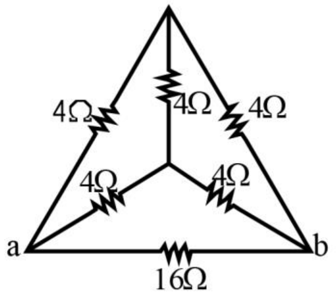
(1) 5 kΩ (2) 30 kΩ

(3) 10 kΩ (4) 20 kΩ

SOLUTION

8. The number density of free electrons in copper is nearly $8 \times 10^{28}\ m^{-3}$. A copper wire has its area of cross section $= 2 \times 10^{-6}\ m^2$ and is carrying a current of 3.2 A. The drift speed of the electrons is _____________ $\times 10^{-6}\ ms^{-1}$.

9. The equivalent resistance of the circuit shown below between points a and b is :



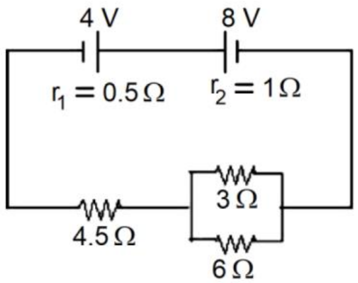
(1) 24Ω (2) 3.2Ω
(3) 20Ω (4) 16Ω

10. 10 resistors each of resistance 10Ω can be connected in such as to get maximum and minimum equivalent resistance. The ratio of maximum and minimum equivalent resistance will be ________ .

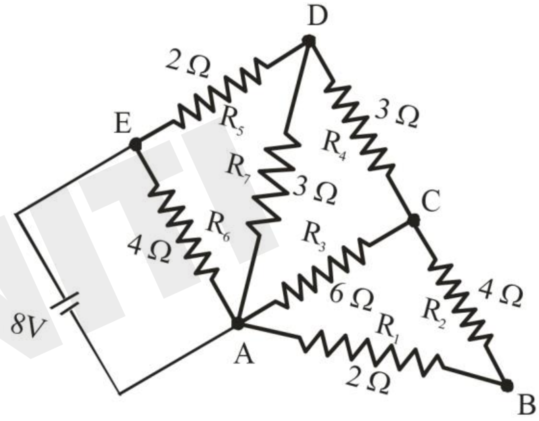
11. A rectangular parallelopiped is measured as 1 cm × 1 cm × 100 cm. If its specific resistance is $3 \times 10^{-7}\ \Omega m$, then the resistance between its two opposite rectangular faces will be______$\times^{-7}\ \Omega$.

12. Two identical heater filaments are connected first in parallel and then in series. At the same applied voltage, the ratio of heat produced in same time for parallel to series will be:
(1) 4 : 1 (2) 2 : 1 (3) 1 : 2 (4) 1 : 4

13. In the circuit diagram shown in figure given below, the current flowing through resistance $3\,\Omega$ is $\frac{x}{3}$A. The value of x is ____.



14.



The current flowing through R_2 is:

(1) $\frac{2}{3}$A (3) $\frac{1}{2}$A

(2) $\frac{1}{4}$A (4) $\frac{1}{3}$A

15. Two identical cells each of emf 1.5 V are connected in series across a 10 Ω resistance. An ideal voltmeter connected across 10 Ω resistance reads 1.5 V. The internal resistance of each cell is ____Ω.

SOLUTION

16. A wire of resistance 160 Ω is melted and drawn in wire of one-fourth of its length. The new resistance of the wire will be

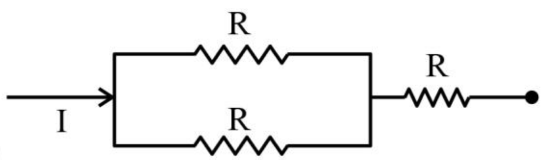
(1) 10 Ω (2) 640 Ω

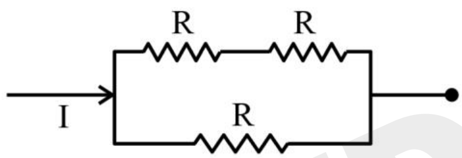
(3) 40 Ω (4) 16 Ω

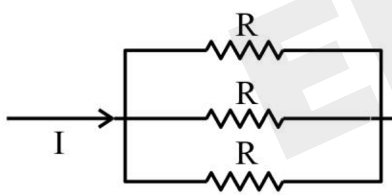
17. The current flowing through a conductor connected across a source is 2A and 1.2 A at 0°C and 100°C respectively. The current flowing through the conductor at 50°C will be _______ $\times 10^2$ mA.

18. Different combination of 3 resistors of equal resistance R are shown in the figures.

The increasing order for power dissipation is:

(A)


(B)


(C)


(D)

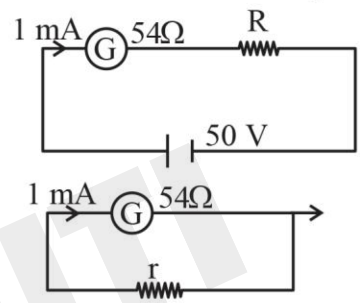

(1) $P_A < P_B < P_C < P_D$ (3) $P_B < P_C < P_D < P_A$

(2) $P_C < P_D < P_A < P_B$ (4) $P_C < P_B < P_A < P_D$

19. A potential V_0 is applied across a uniform wire of resistance R. The power dissipation is P_1. The wire is then cut into two equal halves and a potential of V_0 is applied across the length of each half. The total power dissipation across two wires is P_2. The ratio $P_2 : P_1$ is $\sqrt{x}:1$. The value of x is ___________.

20. When a resistance of 5Ω is shunted with a moving coil galvanometer, it shows a full scale deflection for a current of 250 mA, however when 1050 Ω resistance is connected with it in series, it gives full scale deflection for 25 volt. The resistance of galvanometer is _________ Ω.

21. For designing a voltmeter of range 50 V and an ammeter of range 10 mA using a galvanometer which has a coil of resistance 54 Ω showing a full scale deflection for 1 mA as in figure.



(A) for voltmeter R ≈ 50 kΩ

(B) for ammeter r ≈ 0.2 Ω

(C) for ammeter r ≈ 6 Ω

(D) for voltmeter R ≈ 5 kΩ

(E) for voltmeter R ≈ 500 Ω

Choose the correct answer from the options given below :

(1) (C) and (E) (2) (C) and (D)

(3) (A) and (C) (4) (A) and (B)

SOLUTION

22. **Statement I** : The equivalent resistance of resistors in a series combination is smaller than least resistance used in the combination.

Statement II : The resistivity of the material is independent of temperature.

In the light of the above statements, choose the correct answer from the options given below :

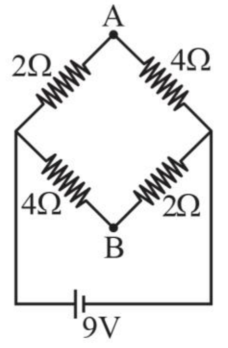
(1) Statement I is false but Statement II is true

(2) Both Statement I and Statement II are false

(3) Statement I is true but Statement II is false

(4) Both Statement I and Statement II are true

23. A network of four resistances is connected to 9V battery, as shown in figure. The magnitude of voltage difference between the points A and B is __________V.

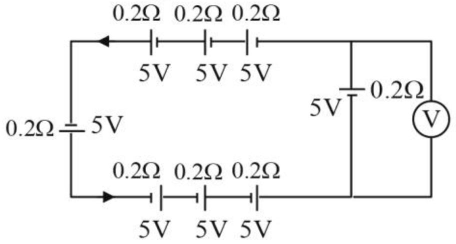


SOLUTION

Current Electricity

1. 2
2. 25
3. 1
4. 3
5. 20
6. 25
7. 1
8. 125
9. 2
10. 100
11. 3
12. 1
13. 1
14. 4
15. 5
16. 1
17. 15
18. 4
19. 16
20. 50
21. 3
22. 2
23. 3

1. The reading in the ideal voltmeter (V) shown in the given circuit diagram is :



(1) 5V (2) 10V
(3) 0 V (4) 3V

2. A galvanometer has a resistance of 50 Ω and it allows maximum current of 5 mA. It can be converted into voltmeter to measure upto 100 V by connecting in series a resistor of resistance
(1) 5975 Ω
(2) 20050 Ω
(3) 19950 Ω
(4) 19500 Ω

3. The current in a conductor is expressed as $I = 3t^2 + 4t^3$, where I is in Ampere and t is in second. The amount of electric charge that flows through a section of the conductor during t = 1s to t = 2s is ____________ C.

4. In an ammeter, 5% of the main current passes through the galvanometer. If resistance of the galvanometer is G, the resistance of ammeter will be :

(1) $\frac{G}{200}$ (2) $\frac{G}{199}$
(3) 199 G (4) 200 G

5. In a metre-bridge when a resistance in the left gap is 2Ω and unknown resistance in the right gap, the balance length is found to be 40 cm. On shunting the unknown resistance with 2Ω, the balance length changes by :
(1) 22.5 cm (2) 20 cm
(3) 62.5 cm (4) 65 cm

6. A wire of length 10 cm and radius $\sqrt{7} \times 10^{-4}$ m connected across the right gap of a meter bridge. When a resistance of 4.5 Ω is connected on the left gap by using a resistance box, the balance length is found to be at 60 cm from the left end. If the resistivity of the wire is $R \times 10^{-7}$ Ωm, then value of R is :
(1) 63 (2) 70
(3) 66 (4) 35

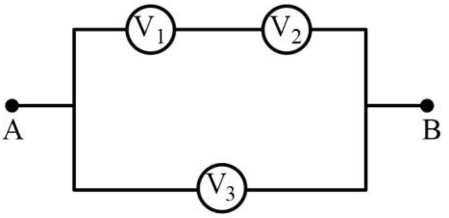
7. A wire of resistance R and length L is cut into 5 equal parts. If these parts are joined parallelly, then resultant resistance will be :

(1) $\frac{1}{25}R$ (3) 25 R
(4) 5 R
(2) $\frac{1}{5}R$

8. Wheatstone bridge principle is used to measure the specific resistance (S_1) of given wire, having length L, radius r. If X is the resistance of wire, then specific resistance is : $S_1 = X\left(\frac{\pi r^2}{L}\right)$. If the length of the wire gets doubled then the value of specific resistance will be :

(1) $\frac{S_1}{4}$ (2) $2S_1$
(3) $\frac{S_1}{2}$ (4) S_1

9. Three voltmeters, all having different internal resistances are joined as shown in figure. When some potential difference is applied across A and B, their readings are V_1, V_2 and V_3. Choose the correct option.



(1) $V_1 = V_2$
(2) $V_1 \neq V_3 - V_2$
(3) $V_1 + V_2 > V_3$
(4) $V_1 + V_2 = V_3$

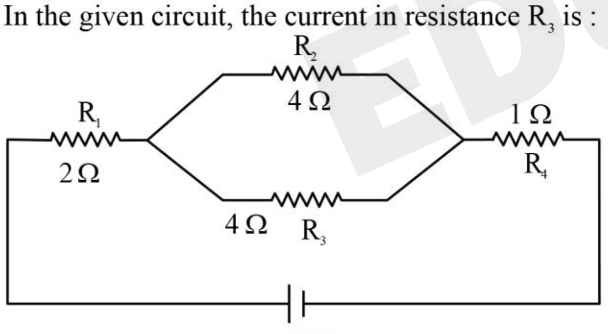
SOLUTION - CLICK

10. The electric current through a wire varies with time as $I = I_0 + \beta t$. where $I_0 = 20$ A and $\beta = 3$ A/s. The amount of electric charge crossed through a section of the wire in 20 s is :
(1) 80 C (2) 1000 C
(3) 800 C (4) 1600 C

11. A galvanometer having coil resistance $10\,\Omega$ shows a full scale deflection for a current of 3mA. For it to measure a current of 8A, the value of the shunt should be:
(1) $3 \times 10^{-3}\Omega$ (3) $3.75 \times 10^{-3}\Omega$
(2) $4.85 \times 10^{-3}\Omega$ (4) $2.75 \times 10^{-3}\Omega$

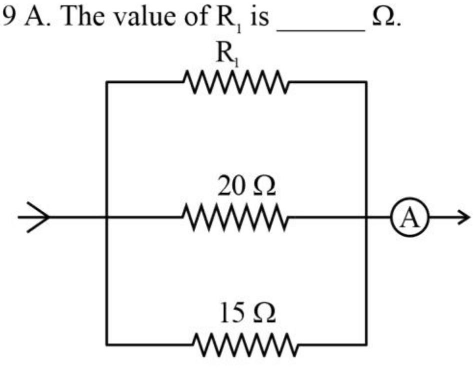
12. The deflection in moving coil galvanometer falls from 25 divisions to 5 division when a shunt of 24Ω is applied. The resistance of galvanometer coil will be :
(1) 12Ω (2) 96Ω
(3) 48Ω (4) 100Ω

13. In the given circuit, the current in resistance R_3 is :

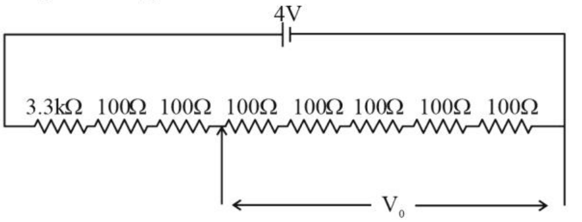


(1) 1 A (2) 1.5 A
(3) 2 A (4) 2.5 A

14. In the given circuit, the current flowing through the resistance 20Ω is 0.3 A, while the ammeter reads 0.9 A. The value of R_1 is _______ Ω.



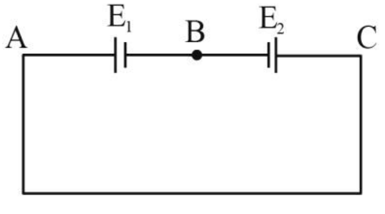
15. A potential divider circuit is shown in figure. The output voltage V_0 is



(1) 4V (2) 2 mV
(3) 0.5 V (4) 12 mV

16. An electric toaster has resistance of $60\ \Omega$ at room temperature (27ºC). The toaster is connected to a 220 V supply. If the current flowing through it reaches 2.75 A, the temperature attained by toaster is around : (if $\alpha = 2\times10^{-4}/^{o}C$)
(1) 694ºC
(2) 1235ºC
(3) 1694ºC
(4) 1667ºC

17. Two cells are connected in opposition as shown. Cell E_1 is of 8 V emf and 2Ω internal resistance; the cell E_2 is of 2 V emf and 4Ω internal resistance. The terminal potential difference of cell E_2 is:



18. When a potential difference V is applied across a wire of resistance R, it dissipates energy at a rate W. If the wire is cut into two halves and these halves are connected mutually parallel across the same supply, the same supply, the energy dissipation rate will become:
(1) 1/4W
(2) 1/2W
(3) 2W
(4) 4W

19. Two resistance of 100 Ω and 200 Ω are connected in series with a battery of 4 V and negligible internal resistance. A voltmeter is used to measure voltage across 100 Ω resistance, which gives reading as 1 V. The resistance of voltmeter must be_______Ω.

20. If the percentage errors in measuring the length and the diameter of a wire are 0.1% each. The percentage error in measuring its resistance will be:

(1) 0.2% (2) 0.3%

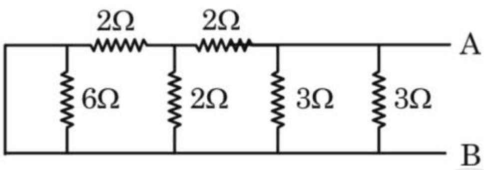
(3) 0.1% (4) 0.144%

21 Two conductors have the same resistances at 0°C but their temperature coefficients of resistance are α_1 and α_2. The respective temperature coefficients for their series and parallel combinations are :

(1) $\alpha_1 + \alpha_2, \dfrac{\alpha_1 + \alpha_2}{2}$ (3) $\alpha_1 + \alpha_2, \dfrac{\alpha_1 \alpha_2}{\alpha_1 + \alpha_2}$

(2) $\dfrac{\alpha_1 + \alpha_2}{2}, \dfrac{\alpha_1 + \alpha_2}{2}$ (4) $\dfrac{\alpha_1 + \alpha_2}{2}, \alpha_1 + \alpha_2$

22. Equivalent resistance of the following network is ______ Ω.



23. The resistance per centimeter of a meter bridge wire is r, with X Ω resistance in left gap. Balancing length from left end is at 40 cm with 25 Ω resistance in right gap. Now the wire is replaced by another wire of 2r resistance per centimeter. The new balancing length for same settings will be at

(1) 20 cm (2) 10 cm

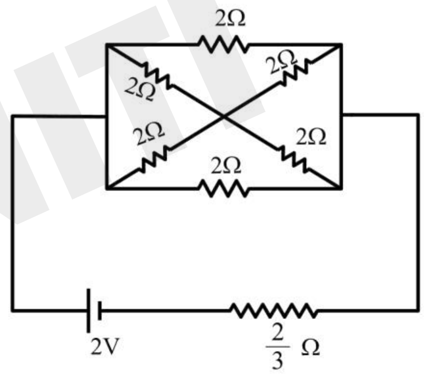
(3) 80 cm (4) 40 cm

24. By what percentage will the illumination of the lamp decrease if the current drops by 20%?

(1) 46% (2) 26%

(3) 36% (4) 56%

25. In the following circuit, the battery has an emf of 2 V and an internal resistance of $\frac{2}{3}\Omega$. The power consumption in the entire circuit is ______ W.



SOLUTION - CLICK

Answer Key

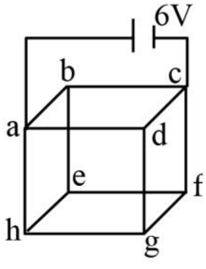
1. 3
2. 3
3. 22
4. NTA Gave Option 1 but answer will be G/20
5. 1
6. 3
7. 1
8. 4
9. 4
10. 2
11. 3
12. 2
13. 1
14. 30
15. 3
16. 3
17. 6
18. 4
19. 200
20. 2
21. 2
22. 1
23. 4
24. 3
25. 3

SOLUTION - CLICK

1. The resistances of the platinum wire of a platinum resistance thermometer at the ice point and steam point are 8 Ω and 10 Ω respectively. After inserting in a hot bath of temperature 400°C, the resistance of platinum wire is :
(1) 2Ω
(2) 16 Ω
(3) 8 Ω
(4) 10 Ω

2. To measure the internal resistance of a battery, potentiometer is used. For R = 10 Ω, the balance point is observed at ℓ = 500 cm and for R = 1 Ω the balance point is observed at ℓ = 400 cm. The internal resistance of the battery is approximately :
(1) 0.2 Ω
(2) 0.4 Ω
(3) 0.1 Ω
(4) 0.3 Ω

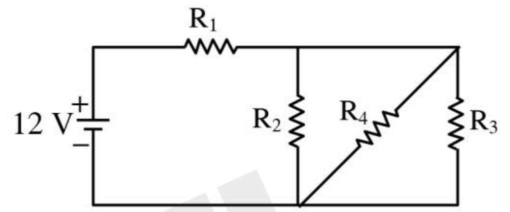
3. Twelve wires each having resistance 2Ω are joined to form a cube. A battery of 6 V emf is joined across point a and c. The voltage difference between e and f is_____ V.



4. An electric bulb rated 50 W – 200 V is connected across a 100 V supply. The power dissipation of the bulb is :
(1) 12.5 W
(2) 25 W
(3) 50 W
(4) 100 W

5. Two wires A and B are made up of the same material and have the same mass. Wire A has radius of 2.0 mm and wire B has radius of 4.0 mm. The resistance of wire B is 2Ω. The resistance of wire A is _____Ω.

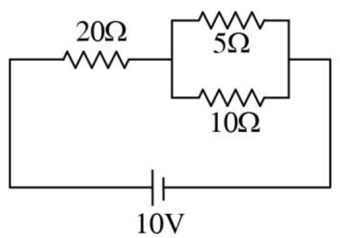
6. In the given figure R_1 = 10Ω, R_2 = 8Ω, R_3 = 4Ω and R_4 = 8Ω. Battery is ideal with emf 12V. Equivalent resistant of the circuit and current supplied by battery are respectively.



(1) 12 Ω and 11.4 A
(2) 10.5 Ω and 1.14 A
(3) 10.5 Ω and 1 A
(4) 12 Ω and 1 A

7. A galvanometer of resistance 100 Ω when connected in series with 400 Ω measures a voltage of upto 10 V. The value of resistance required to convert the galvanometer into ammeter to read upto 10 A is $x \times 10^{-2}$ Ω. The value of x is :
(1) 2
(2) 800
(3) 20
(4) 200

8. The ratio of heat dissipated per second through the resistance 5 Ω and 10 Ω in the circuit given below is :

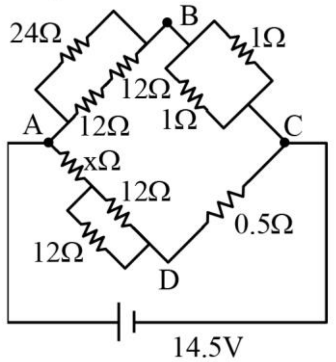


(1) 1 : 2
(2) 2 : 1
(3) 4 : 1
(4) 1 : 1

SOLUTION - CLICK

9. A wire of resistance 20 Ω is divided into 10 equal parts. A combination of two parts are connected in parallel and so on. Now resulting pairs of parallel combination are connected in series. The equivalent resistance of final combination is _______ Ω.

10. The value of unknown resistance (x) for which the potential difference between B and D will be zero in the arrangement shown, is :

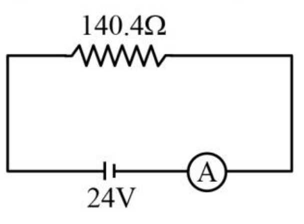


(1) 3 Ω (2) 9 Ω
(3) 6 Ω (4) 42 Ω

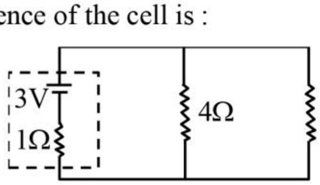
11. A wire of resistance R and radius r is stretched till its radius became r/2. If new resistance of the stretched wire is x R, then value of x is _________.

12. The number of electrons flowing per second in the filament of a 110 W bulb operating at 220 V is :
(Given $e = 1.6 \times 10^{-19}$ C)
(1) 31.25×10^{17} (2) 6.25×10^{18}
(3) 6.25×10^{17} (4) 1.25×10^{19}

13. In the given figure an ammeter A consists of a 240Ω coil connected in parallel to a 10 Ω shunt. The reading of the ammeter is ______ mA.



14. In the given circuit, the terminal potential difference of the cell is :



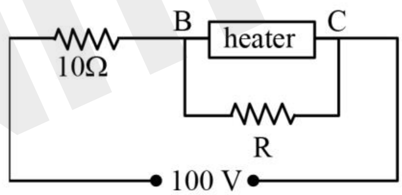
(1) 2 V (2) 4 V
(3) 1.5 V (4) 3 V

15. Resistance of a wire at 0 °C, 100 °C and t °C is found to be 10 Ω, 10.2 Ω and 10.95 Ω respectively. The temperature t in Kelvin scale is______.

16. Water boils in an electric kettle in 20 minutes after being switched on. Using the same main supply, the length of the heating element should be ………….. to …………. times of its initial length if the water is to be boiled in 15 minutes.

(1) increased, $\frac{3}{4}$ (2) increased, $\frac{4}{3}$
(3) decreased, $\frac{3}{4}$ (4) decreased, $\frac{4}{3}$

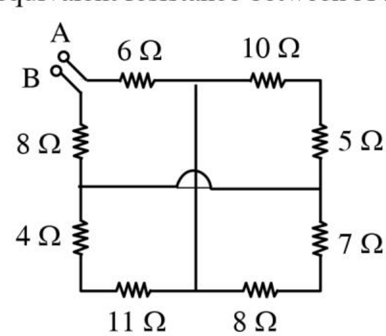
17. A heater is designed to operate with a power of 1000 W in a 100 V line. It is connected in combination with a resistance of 10 Ω and a resistance R, to a 100 V mains as shown in figure. For the heater to operate at 62.5 W, the value of R should be ……………. Ω.



18. A galvanometer has a coil of resistance 200 Ω with a full scale deflection at 20 μA. The value of resistance to be added to use it as an ammeter of range (0–20) mA is:

(1) 0.40 Ω (2) 0.20 Ω
(3) 0.50 Ω (4) 0.10 Ω

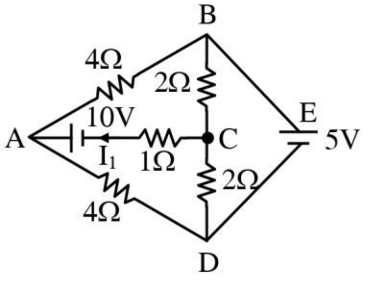
19. The equivalent resistance between A and B is:



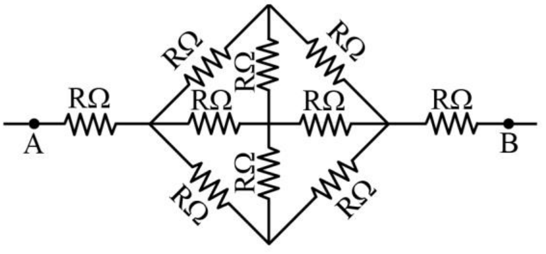
(1) 18 Ω (2) 25 Ω
(3) 27 Ω (4) 19 Ω

SOLUTION - CLICK

20. The current flowing through the 1 Ω resistor is $\frac{n}{10}$ A. The value of n is ________.



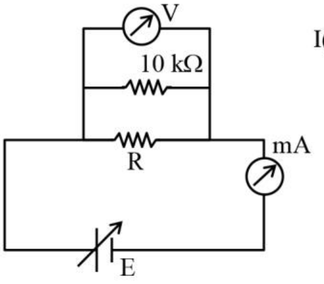
21. The effective resistance between A and B, if resistance of each resistor is R, will be

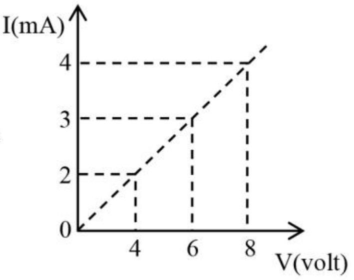


(1) $\frac{2}{3}R$ (2) $\frac{8R}{3}$

(3) $\frac{5R}{3}$ (4) $\frac{4R}{3}$

22. To determine the resistance (R) of a wire, a circuit is designed below, The V-I characteristic curve for this circuit is plotted for the voltmeter and the ammeter readings as shown in figure. The value of R is ………… Ω.





23. At room temperature (27ºC), the resistance of a heating element is 50Ω. The temperature coefficient of the material is 2.4×10^{-4} ºC^{-1}. The temperature of the element, when its resistance is 62 Ω, is …………. ºC.

SOLUTION - CLICK

Answer Key

1. 2
2. 4
3. 1
4. 1
5. 32
6. 4
7. 3
8. 2
9. 5
10. 3
11. 16
12. 1
13. 160
14. 1
15. 748
16. 3
17. 5
18. 2
19. 4
20. 25
21. 2
22. 2500
23. 1027

SOLUTION - CLICK

1. An electron is moving along $+x$ direction with a velocity of $6\times10^6\ \text{ms}^{-1}$. It enters a region of uniform electric field of 300 V/cm pointing along $+y$ direction. The magnitude and direction of the magnetic field set up in this region such that the electron keeps moving along the x direction will be

(a) 5×10^{-3} T, along $+z$ direction
(b) 3×10^{-4} T, along $-z$ direction
(c) 3×10^{-4} T, along $+z$ direction
(d) 5×10^{-3} T, along $-z$ direction

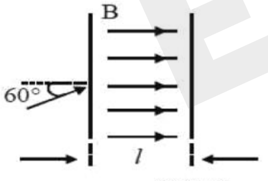
2. A particle of mass m and charge q has an initial velocity $\vec{v}=v_0\hat{j}$. If an electric field $\vec{E}=E_0\hat{i}$ and mangetic field $\vec{B}=B_0\hat{i}$ act on the particle, its speed will double after a time

(a) $\frac{\sqrt{3}mv_0}{qE_0}$ (b) $\frac{3mv_0}{qE_0}$
(c) $\frac{\sqrt{2}mv_0}{qE_0}$ (d) $\frac{2mv_0}{qE_0}$

3. Proton with kinetic energy of 1 MeV moves from south to north. It gets an acceleration of $10^{12}\ \text{m/s}^2$ by an applied magnetic field (west to east). The value of magnetic field is (Rest mass of proton is 1.6×10^{-27} kg)

(a) 7.1 mT (b) 71 mT
(c) 0.071 mT (d) 0.71 mT

4. The figure shows a region of length 'l' with a uniform magnetic field of 0.3 T in it and a proton entering the region with velocity $4\times10^5\ \text{ms}^{-1}$ making an angle 60° with the field. If the proton completes 10 revolution by the time it cross the region shown, 'l' is close to (mass of proton $=1.67\times10^{-27}$ kg, charge of the proton $=1.6\times10^{-19}$ C)



(a) 0.11 m (b) 0.22 m
(c) 0.44 m (d) 0.88 m

5. A charged particle carrying charge 1 μC is moving with velocity $(2\hat{i}+3\hat{j}+4\hat{k})\ \text{ms}^{-1}$. If an external magnetic field of $(5\hat{i}+3\hat{j}-6\hat{k})\times10^{-3}$ T exists in the region where the particle is moving then the force on the particle is $\vec{F}\times10^{-9}$ N. The vector $\vec{F}$ is

(a) $-0.30\hat{i}+0.32\hat{j}-0.09\hat{k}$ (b) $-300\hat{i}+320\hat{j}-90\hat{k}$
(c) $-30\hat{i}+32\hat{j}-9\hat{k}$ (d) $-3.0\hat{i}+3.2\hat{j}-0.9\hat{k}$

6. A charged particle of mass 'm' and charge 'q' moving under the influence of uniform electric field $E\vec{i}$ and a uniform magnetic field $B\vec{k}$ follows a trajectory from point P to Q as shown in figure. The velocities at P and Q are respectively, $v\vec{i}$ and $-2v\vec{j}$. Then which of the following statements (A, B, C, D) are the correct? (Trajectory shown is schematic and not scale)

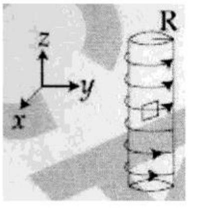
(A) $E=\frac{3}{4}\left(\frac{mv^2}{qa}\right)$
(B) Rate of work done by the electric field at P is $\frac{3}{4}\left(\frac{mv^3}{a}\right)$
(C) Rate of work done by both the fields at Q is zero
(D) The difference between the magnitude of angular momentum of the particle at P and Q is $2mav$

(a) (A), (C), (D) (b) (A), (B), (C)
(c) (A), (B), (C), (D) (d) (B), (C), (D)

7. A particle moving in the xy plane experiences a velocity dependent force $\vec{F}=k(v_y\hat{i}+v_x\hat{j})$, where v_x and v_y are the x and y components of its velocity $\vec{v}$. If $\vec{a}$ be the acceleration of the particle, then which of the following statements is true for the particle?

(a) quantity $\vec{v}\cdot\vec{a}$ is constant in time
(b) kinetic energy of particle is constant in time.
(c) quantity $\vec{v}\times\vec{a}$ is constant in time
(d) $\vec{F}$ arises due to a magnetic field.

8. An electron gun is placed inside a long solenoid of radius R on its axis. The solenoid has n turns/length and carries a current I. The electron gun shoots an electron along the radius of the solenoid with speed v. If the electron does not hit the surface of the solenoid, maximum possible value of v is (all symbols have their standard meaning)



(a) $\frac{2e\mu_0 nIR}{m}$
(b) $\frac{e\mu_0 nIR}{2m}$
(c) $\frac{e\mu_0 nIR}{4m}$ (d) $\frac{e\mu_0 nIR}{m}$

9. A beam of protons with speed $4\times10^5\ \text{ms}^{-1}$ enters a uniform magnetic field of 0.3 T at an angle of 60° to the magnetic field. The pitch of the resulting helical path of protons is close to (Mass of the proton $=1.67\times10^{-27}$ kg, charge of the proton $=1.69\times10^{-19}$ C)

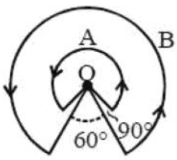
(a) 2 cm (b) 12 cm
(c) 5 cm (d) 4 cm

10. A particle of charge q and mass m is moving with a velocity $-v\hat{i}\,(v\neq0)$ towards a large screen placed in the Y-Z plane at a distance d. If there is a magnetic field $\vec{B}=B_0\hat{k}$, the maximum value of v for which the particle will not hit the screen is

(a) $\frac{qdB_0}{2m}$ (b) $\frac{qdB_0}{m}$
(c) $\frac{2qdB_0}{m}$ (d) $\frac{qdB_0}{3m}$

SOLUTION

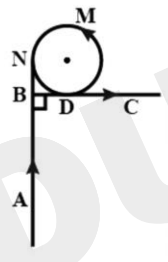
11. A wire A, bent in the shape of an arc of a circle, carrying a current of 2A and having radius 2 cm and another wire B, also bent in the shape of arc of a circle, carrying a current of 3A and having radius of 4 cm, are placed as shown in the figure. The ratio of the magnetic fields due to the wires A and B at the common centre O is



(a) 4 : 6 (b) 6 : 4
(c) 6 :5 (d) 2 : 5

12. A long, straight wire of radius a carries a current distributed uniformly over its cross-section. The ratio of the magnetic fields due to the wire at distance $a/3$ and $2a$, respectively from the axis of the wire is
(a) 3/2 (b) 2
(c) 2/3 (d) 1/2

13. A very long wire $ABDMNDC$ is shown in figure carrying current I. AB and BC parts are straight, long and at right angle. At D, wire forms a circular turn $DMND$ of radius R. AB, BC parts are tangential to circular turn at N and D. Magnetic field at the centre of circle is



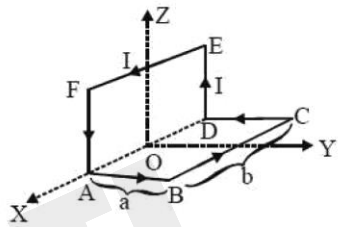
(a) $\frac{\mu_0 I}{2\pi R}\left(\pi+\frac{1}{\sqrt{2}}\right)$
(b) $\frac{\mu_0 I}{2R}$
(c) $\frac{\mu_0 I}{2\pi R}(\pi+1)$ (d) $\frac{\mu_0 I}{2\pi R}\left(\pi-\frac{1}{\sqrt{2}}\right)$

14. Magnitude of magnetic field (in SI units) at the centre of a hexagonal shape coil of side 10 cm, 50 turns and carrying current I (Ampere) in units of $\frac{\mu_0 I}{\pi}$ is
(a) $250\sqrt{3}$ (b) $5\sqrt{3}$
(c) $500\sqrt{3}$ (d) $50\sqrt{3}$

15. A circular coil has moment of inertia 0.8 kg m² around any diameter and is carrying current to produce a magnetic moment of 20 Am². The coil is kept initially in a vertical position and it can rotate freely around a horizontal diameter. When a uniform magnetic field of 4T is applied along the vertical, it starts rotating around its horizontal diameter. The angular speed the coil acquires after rotating by 60° will be
(a) 13 rad s^{-1} (b) 20π rad s^{-1}
(c) 10π rad s^{-1} (d) 20 rad s^{-1}

16. A small circular loop of conducting wire has radius a and carries current I. It is placed in a uniform magnetic field B perpendicular to its plane such that when rotated slightly about its diameter and released, it starts performing simple harmonic motion of time period T. If the mass of the loop is m, then
(d) $T=\sqrt{\frac{\pi m}{IB}}$ (b) $T=\sqrt{\frac{\pi m}{2IB}}$
(c) $T=\sqrt{\frac{2m}{IB}}$ (d) $T=\sqrt{\frac{2\pi m}{IB}}$

17. A wire carrying current I is bent in the shape $ABCDEFA$ as shown, where rectangle $ABCDA$ and $ADEFA$ are perpendicular to each other. If the sides of the rectangles are of lengths a and b, then the magnitude and direction of magnetic moment of the loop $ABCDEFA$ is



(a) $\sqrt{2}abI$, along $\left(\frac{\hat{j}}{\sqrt{2}}+\frac{\hat{k}}{\sqrt{2}}\right)$
(b) $\sqrt{2}abI$, along $\left(\frac{\hat{j}}{\sqrt{5}}+\frac{2\hat{k}}{\sqrt{5}}\right)$
(c) abI, along $\left(\frac{\hat{j}}{\sqrt{2}}+\frac{\hat{k}}{\sqrt{2}}\right)$ (d) abI, along $\left(\frac{\hat{j}}{\sqrt{5}}+\frac{2\hat{k}}{\sqrt{5}}\right)$

18. A square loop of side $2a$, and carrying current I, is kept in XZ plane with its centre at origin. A long wire carrying the same current I is placed parallel to the z-axis and passing through the point $(0, b, 0)$, $(b >> a)$. The magnitude of the torque on the loop about z-axis is given by
(a) $\frac{2\mu_0 I^2 a^2}{\pi b}$ (b) $\frac{\mu_0 I^2 a^3}{2\pi b^2}$
(c) $\frac{\mu_0 I^2 a^2}{2\pi b}$ (d) $\frac{2\mu_0 I^2 a^3}{\pi b^2}$

19. A charged particle going around in a circle can be considered to be a current loop. A particle of mass m carrying charge q is moving in a plane with speed v under the influence of magnetic field $\vec{B}$. The magnetic moment of this moving particle is
(a) $-\frac{mv^2\vec{B}}{B^2}$ (b) $-\frac{mv^2\vec{B}}{2\pi B^2}$
(c) $\frac{mv^2\vec{B}}{2B^2}$ (d) $-\frac{mv^2\vec{B}}{2B^2}$

SOLUTION

20. A galvanometer is used in laboratory for detecting the null point in electrical experiments. If, on passing a current of 6mA it produces a deflection of 2°, its figure of merit is close to

(a) 3×10^{-3} A/div. (b) 333° A/div.
(c) 6×10^{-3} A/div. (d) 666° A/div.

21. A small bar magnet placed with its axis at 30° with an external field of 0.06 T experiences a torque of 0.018 Nm. The minimum work required to rotate it from its stable to unstable equilibrium position is

(a) 9.2×10^{-3} J (b) 6.4×10^{-2} J
(c) 11.7×10^{-3} J (d) 7.2×10^{-2} J

22. A paramagnetic sample shows a net magnetisation of 6 A/m when it is placed in an external magnetic field of 0.4 T at a temperature of 4 K. When the sample is placed in an external magnetic field of 0.3 T at a temperature of 24 K, then the magnetisation will be

(a) 4 A/m (b) 0.75 A/m
(c) 2.25 A/m (d) 1 A/m

23. A perfectly dimagnetic sphere has a small spherical cavity at its centre, which is filled with a paramagnetic substance. The whole system is placed in a uniform magnetic field $\vec{B}$. Then the field inside the paramagnetic substance is

(a) Zero (b) $\vec{B}$
(c) much larger than $|\vec{B}|$ but opposite to $\vec{B}$
(d) much larger than $|\vec{B}|$ and parallel to $\vec{B}$

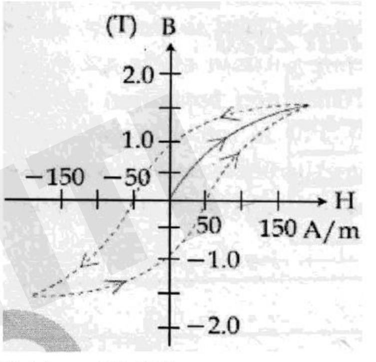
24. An iron rod of volume 10^{-3}m^3 and relative permeability 1000 is placed as core in a solenoid with 10 turns/cm. If a current of 0.5 A is passed through the solenoid, then the magnetic moment of the rod will be

(a) 0.5×10^2 Am^2 (b) 50×10^2 Am^2
(c) 500×10^2 Am^2 (d) 5×10^2 Am^2

25. Magnetic materials used for making permanent magnets (P) and magnets in a transformer (T) have different properties. Of the following, which property best matches for the type of magnet required?

(a) T : Large retentivity, small coercivity
(b) P : Large retentivity, large coercivity
(c) P : Small retentivity, large coercivity
(d) T : Large retentivity, large coercivity

26. The figure gives experimentally measured B vs H variation in a ferromagnetic material. The retentivity, coercivity and saturation, respectively, of the material are



(a) 1.5 T, 50 A/m and 1.0 T
(b) 1.0 T, 50 A/m and 1.5 T
(c) 1.5 T, 50 A/m and 1.0 T
(d) 150 A/m, 1.0 T and 1.5 T

27. A galvanometer coil has 500 turns and each turn has an average area of 3×10^{-4} m^2. If a torque of 1.5 Nm is required to keep this coil parallel to magnetic field when a current of 0.5 A is flowing through it, the strength of the field (in T) is_______.

SOLUTION

ANSWER KEY

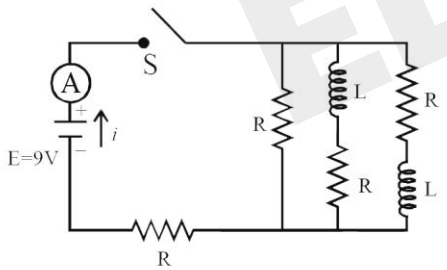
1. a
2. a
3. d
4. c
5. c
6. b
7. c
8. b
9. d
10. b
11. c
12. c
13. a
14. c
15. a
16. d
17. a
18. a
19. d
20. a
21. d
22. b
23. a
24. d
25. b
26. b
27. 20

Feb Attempt *(Magnetism & EMI)*

Following are Magnetism Questions from Feb Attempt 2021
Q1, Q3, Q4, Q5

1. A soft ferromagnetic material is placed in an external magnetic field. The magnetic domains :
(1) increase in size but no change in orientation.
(2) have no relation with external magnetic field.
(3) decrease in size and changes orientation.
(4) may increase or decrease in size and change its orientation.

2. Figure shows a circuit that contains four identical resistors with resistance R = 2.0 Ω, two identical inductors with inductance L = 2.0 mH and an ideal battery with *emf* E = 9 V. The current '*i*' just after the switch 'S' is closed will be :
(1) 2.25 A (2) 3.0 A
(3) 3.37 A (4) 9 A



3. In a ferromagnetic material, below the curie temperature, a domain is defined as :
(1) a macroscopic region with zero magnetization.
(2) a macroscopic region with consecutive magnetic dipoles oriented in opposite direction.
(3) a macroscopic region with randomly oriented magnetic dipoles.
(4) a macroscopic region with saturation magnetization.

4. A proton, a deuteron and an α particle are moving with same momentum in a uniform magnetic field. The ratio of magnetic forces acting on them is ____ and their speed is ____ in the ratio.
(1) 1 : 2 : 4 and 2 : 1 : 1
(2) 2 : 1 : 1 and 4 : 2 : 1
(3) 4 : 2 : 1 and 2 : 1 : 1
(4) 1 : 2 : 4 and 1 : 1 : 2

5. Magnetic fields at two points on the axis of a circular coil at a distance of 0.05m and 0.2 m from the centre are in the ratio 8 : 1. The radius of coil is ____.
(1) 0.2 m (2) 0.1 m
(3) 0.15 m (4) 1.0 m

6. A coil of inductance 2H having negligible resistance is connected to a source of supply whose voltage is given by V = 3t volt. (where t is in second). If the voltage is applied when t = 0, then the energy stored in the coil after 4s is _____ J.

7. An aeroplane, with its wings spread 10 m, is flying at a speed of 180 km/h in a horizontal direction. The total intensity of earth's field at that part is 2.5×10^{-4} Wb/m^2 and the angle of dip is 60°. The emf induced between the tips of the plane wings will be :-
(1) 108.25 mV (3) 88.37 mV
(2) 54.125 mV (4) 62.50 mV

Feb Attempt *(AC)*

1. A series LCR circuit is designed to resonate at an angular frequency $\omega_0 = 10^5$ rad/s. The circuit draws 16 W power from 120 V source at resonance. The value of resistance 'R' in the circuit is ___Ω.

2. A resonance circuit having inductance and resistance 2×10^{-4} H and 6.28 Ω respectively oscillates at 10 MHz frequency. The value of quality factor of this resonator is _______.

SOLUTION

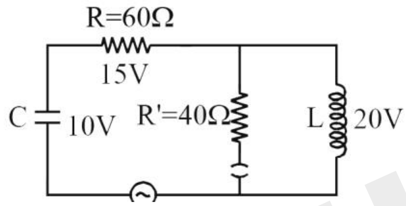
3. An LCR circuit contains resistance of 110 Ω and a supply of 220 V at 300 rad/s angular frequency. If only capacitance is removed from the circuit, current lags behind the voltage by 45°. If on the other hand, only inductor is removed the current leads by 45° with the applied voltage. The rms current flowing in the circuit will be :

(1) 1A (2) 2.5 A

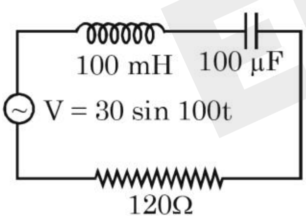
(3) 1.5 A (4) 2A

4. The angular frequency of alternating current in a L-C-R circuit is 100 rad/s. The components connected are shown in the figure. Find the value of inductance of the coil and capacity of condenser.

(1) 0.8 H and 150 μF
(2) 0.8 H and 250 μF
(3) 1.33 H and 250 μF
(4) 1.33 H and 150 μF



5. Find the peak current and resonant frequency of the following circuit (as shown in figure).



(1) 0.2 A and 50 Hz
(2) 0.2 A and 100 Hz
(3) 2 A and 100 Hz
(4) 2A and 50 Hz

6. An alternating current is given by the equation $i = i_1 \sin\omega t + i_2 \cos\omega t$. The rms current will be

(1) $\frac{1}{\sqrt{2}}\left(i_1^2 + i_2^2\right)^{\frac{1}{2}}$ (2) $\frac{1}{\sqrt{2}}\left(i_1 + i_2\right)^2$

(3) $\frac{1}{2}\left(i_1^2 + i_2^2\right)^{\frac{1}{2}}$ (4) $\frac{1}{\sqrt{2}}\left(i_1 + i_2\right)$

7. In a series LCR resonant circuit, the quality factor is measured as 100. If the inductance is increased by two fold and resistance is decreased by two fold, then the quality factor after this change will be_____.

March Attempt *(Magnetism)*

1. A bar magnet of length 14 cm is placed in the magnetic meridian with its north pole pointing towards the geographic north pole. A neutral point is obtained at a distance of 18 cm from the center of the magnet. If $B_H = 0.4$ G, the magnetic moment of the magnet is ($1\ G = 10^{-4} T$)

(1) 2.880×10^3 J T^{-1} (2) 2.880×10^2 J T^{-1}
(3) 2.880 J T^{-1} (4) 28.80 J T^{-1}

2. A charge Q is moving $\vec{dl}$ distance in the magnetic field $\vec{B}$. Find the value of work done by $\vec{B}$.

(1) 1 (2) Infinite
(3) Zero (4) –1

3. A solenoid of 1000 turns per metre has a core with relative permeability 500. Insulated windings of the solenoid carry an electric current of 5A. The magnetic flux density produced by the solenoid is :
(permeability of free space = $4\pi \times 10^{-7}$ H/m)

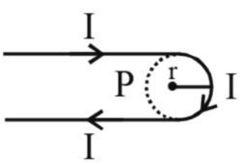
(1) πT (2) $2 \times 10^{-3}\ \pi$T

(3) $\frac{\pi}{5}$T (4) $10^{-4}\pi$T

4. A hairpin like shape as shown in figure is made by bending a long current carrying wire. What is the magnitude of a magnetic field at point P which lies on the centre of the semicircle ?

(1) $\frac{\mu_0 I}{4\pi r}(2-\pi)$ (2) $\frac{\mu_0 I}{4\pi r}(2+\pi)$

(3) $\frac{\mu_0 I}{2\pi r}(2+\pi)$ (4) $\frac{\mu_0 I}{2\pi r}(2-\pi)$



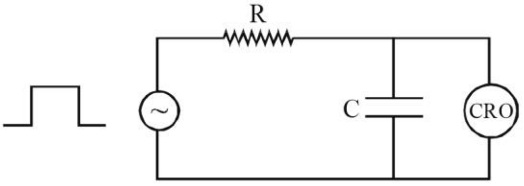
SOLUTION

5. A loop of flexible wire of irregular shape carrying current is placed in an external magnetic field. Identify the effect of the field on the wire.
(1) Loop assumes circular shape with its plane normal to the field.
(2) Loop assumes circular shape with its plane parallel to the field.
(3) Wire gets stretched to become straight.
(4) Shape of the loop remains unchanged.

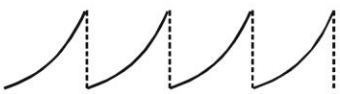
6. Which of the following statements are correct?
(A) Electric monopoles do not exist whereas magnetic monopoles exist.
(B) Magnetic field lines due to a solenoid at its ends and outside cannot be completely straight and confined.
(C) Magnetic field lines are completely confined within a toroid.
(D) Magnetic field lines inside a bar magnet are not parallel.
(E) $\chi = -1$ is the condition for a perfect diamagnetic material, where χ is its magnetic susceptibility.
Choose the correct answer from the options given below :
(1) (C) and (E) only
(2) (B) and (D) only
(3) (A) and (B) only
(4) (B) and (C) only

<u>March Attempt</u> (EMI & AC)

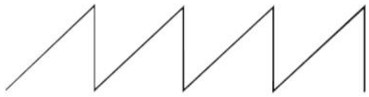
1. An RC circuit as shown in the figure is driven by a AC source generating a square wave. The output wave pattern monitored by CRO would look close to :



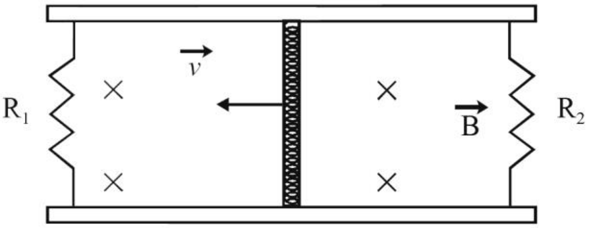
(1) 

(2) 

(3) 

(4) 

2. A conducting bar of length L is free to slide on two parallel conducting rails as shown in the figure

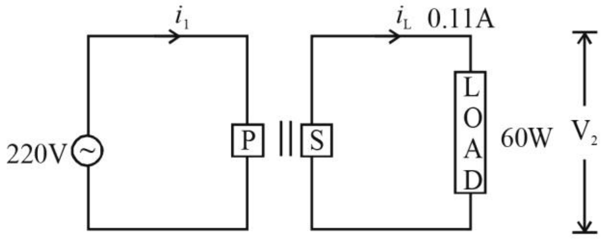


Two resistors R_1 and R_2 are connected across the ends of the rails. There is a uniform magnetic field $\vec{B}$ pointing into the page. An external agent pulls the bar to the left at a constant speed v.
The correct statement about the directions of induced currents I_1 and I_2 flowing through R_1 and R_2 respectively is :
(1) Both I_1 and I_2 are in anticlockwise direction
(2) Both I_1 and I_2 are in clockwise direction
(3) I_1 is in clockwise direction and I_2 is in anticlockwise direction
(4) I_1 is in anticlockwise direction and I_2 is in clockwise direction

3. A sinusoidal voltage of peak value 250 V is applied to a series LCR circuit, in which $R = 8\Omega$, $L = 24$ mH and $C = 60\mu F$. The value of power dissipated at resonant condition is 'x' kW. The value of x to the nearest integer is ________.

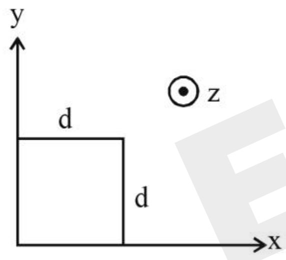
SOLUTION

4. For the given circuit, comment on the type of transformer used :



(1) Auxilliary transformer
(2) Auto transformer
(3) Step-up transformer
(4) Step down transformer

5. The magnetic field in a region is given by $\vec{B} = B_0\left(\frac{x}{a}\right)\hat{k}$. A square loop of side d is placed with its edges along the x and y axes. The loop is moved with a constant velocity $\vec{v} = v_0\hat{i}$. The emf induced in the loop is :



(1) $\frac{B_0 v_0^2 d}{2a}$ (2) $\frac{B_0 v_0 d}{2a}$
(3) $\frac{B_0 v_0 d^2}{a}$ (4) $\frac{B_0 v_0 d^2}{2a}$

6. An AC current is given by $I = I_1 \sin\omega t + I_2 \cos\omega t$. A hot wire ammeter will give a reading :

(1) $\sqrt{\frac{I_1^2 - I_2^2}{2}}$ (2) $\sqrt{\frac{I_1^2 + I_2^2}{2}}$
(3) $\frac{I_1 + I_2}{\sqrt{2}}$ (4) $\frac{I_1 + I_2}{2\sqrt{2}}$

7. Match List-I with List-II

List-I	List-II
(a) Phase difference between current and voltage in a purely resistive AC circuit	(i) $\frac{\pi}{2}$; current leads voltage
(b) Phase difference between current and voltage in a pure inductive AC circuit	(ii) zero
(c) Phase difference between current and voltage in a pure capacitive AC circuit	(iii) $\frac{\pi}{2}$; current lags voltage
(d) Phase difference between current and voltage in an LCR series circuit	(iv) $\tan^{-1}\left(\frac{X_C - X_L}{R}\right)$

Choose the most appropriate answer from the options given below :

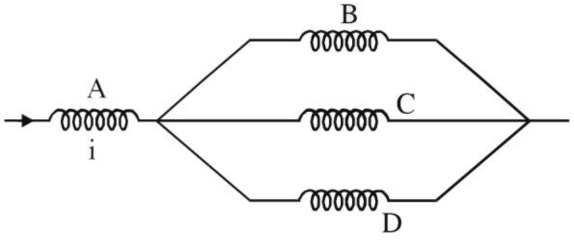
(1) (a)–(i),(b)–(iii),(c)–(iv),(d)–(ii)
(2) (a)–(ii),(b)–(iv),(c)–(iii),(d)–(i)
(3) (a)–(ii),(b)–(iii),(c)–(iv),(d)–(i)
(4) (a)–(ii),(b)–(iii),(c)–(i),(d)–(iv)

8. What happens to the inductive reactance and the current in a purely inductive circuit if the frequency is halved ?

(1) Both, inductive reactance and current will be halved.
(2) Inductive reactance will be halved and current will be doubled.
(3) Inductive reactance will be doubled and current will be halved.
(4) Both, inducting reactance and current will be doubled.

SOLUTION

9. Four identical long solenoids A, B, C and D are connected to each other as shown in the figure. If the magnetic field at the center of A is 3T, the field at the center of C would be : (Assume that the magnetic field is confined with in the volume of respective solenoid).



(1) 12T (2) 6T

(3) 9T (4) 1T

10. In a series LCR resonance circuit, if we change the resistance only, from a lower to higher value :

(1) The bandwidth of resonance circuit will increase.

(2) The resonance frequency will increase.

(3) The quality factor will increase.

(4) The quality factor and the resonance frequency will remain constant.

11. An AC source rated 220 V, 50 Hz is connected to a resistor. The time taken by the current to change from its maximum to the rms value is :

(1) 2.5 ms (2) 25 ms

(3) 2.5 s (4) 0.25 ms

12. In a series LCR circuit, the inductive reactance (X_L) is 10 Ω and the capacitive reactance (X_C) is 4 Ω. The resistance (R) in the circuit is 6 Ω. The power factor of the circuit is :

(1) $\frac{1}{2}$ (2) $\frac{1}{2\sqrt{2}}$

(3) $\frac{1}{\sqrt{2}}$ (4) $\frac{\sqrt{3}}{2}$

13. The time taken for the magnetic energy to reach 25% of its maximum value, when a solenoid of resistance R, inductance L is connected to a battery, is :

(1) $\frac{L}{R}\ell n5$ (2) infinite

(3) $\frac{L}{R}\ell n2$ (4) $\frac{L}{R}\ell n10$

July Attempt (Magnetism)

1. At an angle of 30° to the magnetic meridian, the apparent dip is 45°. Find the true dip :

(1) $\tan^{-1}\sqrt{3}$ (2) $\tan^{-1}\frac{1}{\sqrt{3}}$

(3) $\tan^{-1}\frac{2}{\sqrt{3}}$ (4) $\tan^{-1}\frac{\sqrt{3}}{2}$

2. The magnetic susceptibility of a material of a rod is 499. Permeability in vacuum is $4\pi \times 10^{-7}$ H/m. Absolute permeability of the material of the rod is :

(1) $4\pi \times 10^{-4}$ H/m

(2) $2\pi \times 10^{-4}$ H/m

(3) $3\pi \times 10^{-4}$ H/m

(4) $\pi \times 10^{-4}$ H/m

3. **Statement I :** The ferromagnetic property depends on temperature. At high temperature, ferromagnet becomes paramagnet.

Statement II : At high temperature, the domain wall area of a ferromagnetic substance increases.

In the light of the above statements, choose the **most appropriate** answer from the options given below :

(1) **Statement I** is true but **Statement II** is false

(2) Both **Statement I** and **Statement II** are true

(3) Both **Statement I** and **Statement II** are false

(4) **Statement I** is false but **Statement II** is true

4. Choose the correct option :

(1) True dip is not mathematically related to apparent dip.

(2) True dip is less than apparent dip.

(3) True dip is always greater than the apparent dip.

(4) True dip is always equal to apparent dip.

SOLUTION

5. The value of aluminium susceptibility is 2.2×10^{-5}. The percentage increase in the magnetic field if space within a current carrying toroid is filled with aluminium is $\frac{x}{10^4}$. Then the value of x is ______.

6. Two ions having same mass have charges in the ratio 1 : 2. They are projected normally in a uniform magnetic field with their speeds in the ratio 2 : 3. The ratio of the radii of their circular trajectories is :

(1) 1 : 4 (2) 4 : 3 (3) 3 : 1 (4) 2 : 3

7. In a uniform magnetic field, the magnetic needle has a magnetic moment 9.85×10^{-2} A/m^2 and moment of inertia 5×10^{-6} kg m^2. If it performs 10 complete oscillations in 5 seconds then the magnitude of the magnetic field is ________ mT. [Take π^2 as 9.85]

8. Figure A and B shown two long straight wires of circular cross-section (a and b with a < b), carrying current I which is uniformly distributed across the cross-section. The magnitude of magnetic field B varies with radius r and can be represented as :

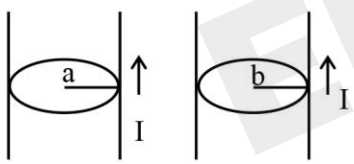
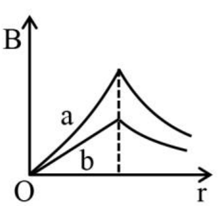
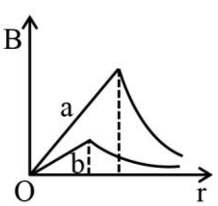
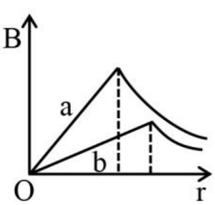
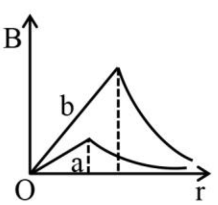


Fig. A Fig. B

(1)


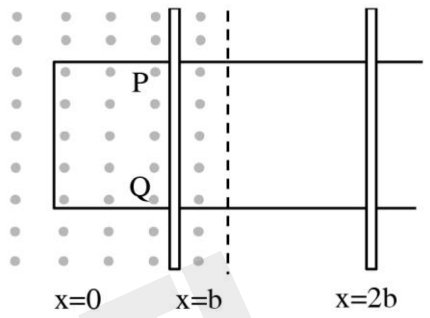
(2)


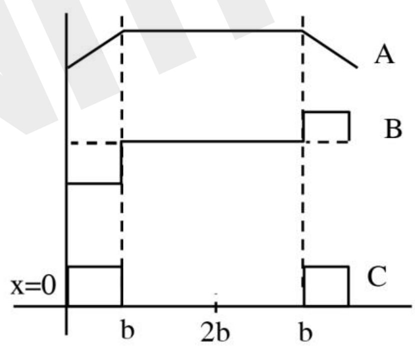
(3)


(4)


July Attempt (EMI)

1. The arm PQ of a rectangular conductor is moving from x = 0 to x = 2b outwards and then inwards from x = 2b to x = 0 as shown in the figure. A uniform magnetic field perpendicular to the plane is acting from x = 0 to x = b. Identify the graph showing the variation of different quantities with distance :





(1) A-Flux, B-Power dissipated, C-EMF

(2) A-Power dissipated, B-Flux, C-EMF

(3) A-Flux, B-EMF, C-Power dissipated

(4) A-EMF, B-Power dissipated, C-Flux

2. An inductor of 10 mH is connected to a 20 V battery through a resistor of 10 kΩ and a switch. After a long time, when maximum current is set up in the circuit, the current is switched off. The current in the circuit after 1 μs is $\frac{x}{100}$ mA . Then x is equal to ______. (Take $e^{-1} = 0.37$)

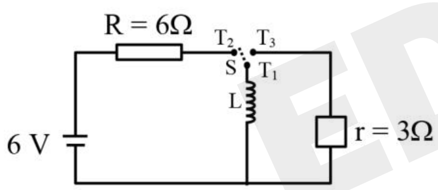
SOLUTION

3. A circular conducting coil of radius 1 m is being heated by the change of magnetic field $\vec{B}$ passing perpendicular to the plane in which the coil is laid. The resistance of the coil is 2 $\mu\Omega$. The magnetic field is slowly switched off such that its magnitude changes in time as

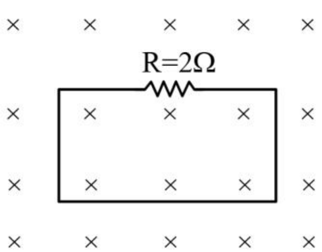
$$B = \frac{4}{\pi} \times 10^{-3} T\left(1 - \frac{t}{100}\right)$$

The energy dissipated by the coil before the magnetic field is switched off completely is E = _____ mJ.

4. Consider an electrical circuit containing a two way switch 'S'. Initially S is open and then T_1 is connected to T_2. As the current in R = 6 Ω attains a maximum value of steady state level, T_1 is disconnected from T_2 and immediately connected to T_3. Potential drop across r = 3 Ω resistor immediately after T_1 is connected to T_3 is______V. (Round off to the Nearest Integer)



5. In the given figure the magnetic flux through the loop increases according to the relation $\phi_B(t) = 10t^2 + 20t$, where ϕ_B is in milliwebers and t is in seconds.
The magnitude of current through R = 2Ω resistor at t = 5 s is ______ mA.



SOLUTION

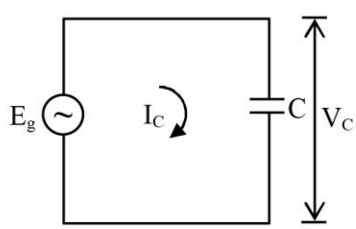
July Attempt (AC)

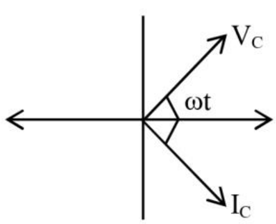
1. In an LCR series circuit, an inductor 30 mH and a resistor 1 Ω are connected to an AC source of angular frequency 300 rad/s. The value of capacitance for which, the current leads the voltage by 45° is $\frac{1}{x} \times 10^{-3}$ F. Then the value of x is ____.

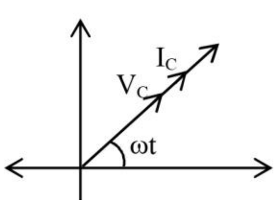
2. For a series LCR circuit with R = 100 Ω, L = 0.5 mH and C = 0.1 pF connected across 220 V–50 Hz AC supply, the phase angle between current and supplied voltage and the nature of the circuit is :
(1) 0°, resistive circuit
(2) ≈ 90°, predominantly inductive circuit
(3) 0°, resonance circuit
(4) ≈ 90°, predominantly capacitive circuit

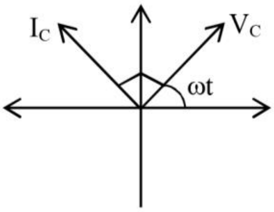
3. A series LCR circuit of R = 5Ω, L = 20 mH and C = 0.5 μF is connected across an AC supply of 250 V, having variable frequency. The power dissipated at resonance condition is_____$\times 10^2$ W.

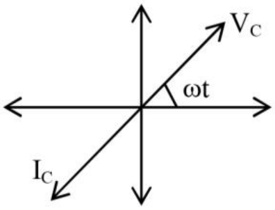
4. In a circuit consisting of a capacitance and a generator with alternating emf $E_g = E_{g_0} \sin\omega t$, V_C and I_C are the voltage and current. Correct phasor diagram for such circuit is :



(1)


(2)


(3) 

(4) 

5. Match **List-I** with **List-II** :

	List–I		List–II
(a)	$\omega L > \frac{1}{\omega C}$	(i)	Current is in phase with emf
(b)	$\omega L = \frac{1}{\omega C}$	(ii)	Current lags behind the applied emf
(c)	$\omega L < \frac{1}{\omega C}$	(iii)	Maximum current occurs
(d)	Resonant frequency	(iv)	Current leads the emf

Choose the **correct** answer from the options given below :

(1) (a) – (ii) ; (b) – (i) ; (c) - (iv) ; (d) – (iii)
(2) (a) – (ii) ; (b) – (i) ; (c) - (iii) ; (d) – (iv)
(3) (a) – (iii) ; (b) – (i) ; (c) - (iv) ; (d) – (ii)
(4) (a) – (iv) ; (b) – (iii) ; (c) - (ii) ; (d) – (i)

6. A 10Ω resistance is connected across 220V – 50Hz AC supply. The time taken by the current to change from its maximum value to the rms value is:

(1) 2.5 ms (2) 1.5 ms
(3) 3.0 ms (4) 4.5 ms

7. Two circuits are shown in the figure (a) & (b). At a frequency of ________ rad/s the average power dissipated in one cycle will be same in both the circuits.

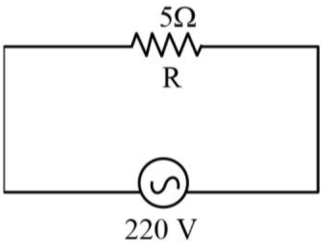


figure (a)

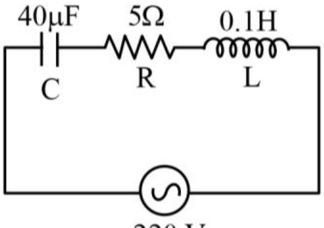


figure (b)

SOLUTION

8. A 0.07 H inductor and a 12 Ω resistor are connected in series to a 220 V, 50 Hz ac source. The approximate current in the circuit and the phase angle between current and source voltage are respectively. [Take π as $\frac{22}{7}$]

(1) 8.8 A and $\tan^{-1}\left(\frac{11}{6}\right)$

(2) 88 A and $\tan^{-1}\left(\frac{11}{6}\right)$

(3) 0.88 A and $\tan^{-1}\left(\frac{11}{6}\right)$

(4) 8.8 A and $\tan^{-1}\left(\frac{6}{11}\right)$

9. A 100 Ω resistance, a 0.1 μF capacitor and an inductor are connected in series across a 250 V supply at variable frequency. Calculate the value of inductance of inductor at which resonance will occur. Given that the resonant frequency is 60 Hz.

(1) 0.70 H (2) 70.3 mH
(3) 7.03×10^{-5} H (4) 70.3 H

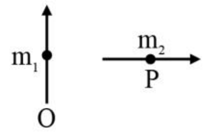
August Attempt (Magnetism*)*

1. The fractional change in the magnetic field intensity at a distance 'r' from centre on the axis of current carrying coil of radius 'a' to the magnetic field intensity at the centre of the same coil is : (Take r < a)

(1) $\frac{3}{2}\frac{a^2}{r^2}$ (2) $\frac{2}{3}\frac{a^2}{r^2}$

(3) $\frac{2}{3}\frac{r^2}{a^2}$ (4) $\frac{3}{2}\frac{r^2}{a^2}$

2. Two short magnetic dipoles m_1 and m_2 each having magnetic moment of 1 Am^2 are placed at point O and P respectively. The distance between OP is 1 meter. The torque experienced by the magnetic dipole m_2 due to the presence of m_1 is ...... $\times 10^{-7}$ Nm.



3. A light beam is described by $E = 800 \sin\omega\left(t - \frac{x}{c}\right)$ .An electron is allowed to move normal to the propagation of light beam with a speed of 3×10^7 ms^{-1}. What is the maximum magnetic force exerted on the electron ?

(1) 1.28×10^{-18} N (3) 12.8×10^{-17} N

(2) 1.28×10^{-21} N (4) 12.8×10^{-18} N

4. If the maximum value of accelerating potential provided by a ratio frequency oscillator is 12 kV. The number of revolution made by a proton in a cyclotron to achieve one sixth of the speed of light is ....

[$m_p = 1.67 \times 10^{-27}$ kg, $e = 1.6 \times 10^{-19}$ C,

Speed of light = 3×10^8 m/s]

5. A coil in the shape of an equilateral triangle of side 10 cm lies in a vertical plane between the pole pieces of permanent magnet producing a horizontal magnetic field 20 mT. The torque acting on the coil when a current of 0.2 A is passed through it and its plane becomes parallel to the magnetic field will be $\sqrt{x} \times 10^{-5}$ Nm. The value of x is...........

6. Two ions of masses 4 amu and 16 amu have charges +2e and +3e respectively. These ions pass through the region of constant perpendicular magnetic field. The kinetic energy of both ions is same. Then :

(1) lighter ion will be deflected less than heavier ion

(2) lighter ion will be deflected more than heavier ion

(3) both ions will be deflected equally

(4) no ion will be deflected.

7. A uniform conducting wire of length is 24a, and resistance R is wound up as a current carrying coil in the shape of an equilateral triangle of side 'a' and then in the form of a square of side 'a'. The coil is connected to a voltage source V_0. The ratio of magnetic moment of the coils in case of equilateral triangle to that for square is $1 : \sqrt{y}$ where y is ....

8. For full scale deflection of total 50 divisions, 50 mV voltage is required in galvanometer. The resistance of galvanometer if its current sensitivity is 2 div/mA will be :

(1) 1 Ω (2) 5 Ω

(3) 4 Ω (4) 2 Ω

9. A coaxial cable consists of an inner wire of radius 'a' surrounded by an outer shell of inner and outer radii 'b' and 'c' respectively. The inner wire carries an electric current i_0, which is distributed uniformly across cross-sectional area. The outer shell carries an equal current in opposite direction and distributed uniformly. What will be the ratio of the magnetic field at a distance x from the axis when (i) x < a and (ii) a < x < b ?

(1) $\frac{x^2}{a^2}$ (2) $\frac{a^2}{x^2}$

(3) $\frac{x^2}{b^2 - a^2}$ (4) $\frac{b^2 - a^2}{x^2}$

SOLUTION

10. A coil having N turns is wound tightly in the form of a spiral with inner and outer radii 'a' and 'b' respectively. Find the magnetic field at centre, when a current I passes through coil :

(1) $\frac{\mu_0 IN}{2(b-a)} \log_e\left(\frac{b}{a}\right)$ (2) $\frac{\mu_0 I}{8}\left[\frac{a+b}{a-b}\right]$

(3) $\frac{\mu_0 I}{4(a-b)}\left[\frac{1}{a}-\frac{1}{b}\right]$ (4) $\frac{\mu_0 I}{8}\left(\frac{a-b}{a+b}\right)$

11. A current of 1.5 A is flowing through a triangle, of side 9 cm each. The magnetic field at the centroid of the triangle is :

(Assume that the current is flowing in the clockwise direction.)

(1) 3×10^{-7} T, outside the plane of triangle

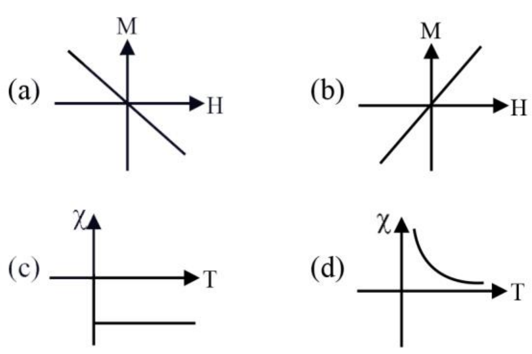
(2) $2\sqrt{3} \times 10^{-7}$ T, outside the plane of triangle

(3) $2\sqrt{3} \times 10^{-5}$ T, inside the plane of triangle

(4) 3×10^{-5} T, inside the plane of triangle

12. A long solenoid with 1000 turns/m has a core material with relative permeability 500 and volume 10^3 cm^3. If the core material is replaced by another material having relative permeability of 750 with same volume maintaining same current of 0.75 A in the solenoid, the fractional change in the magnetic moment of the core would be approximately $\left(\frac{x}{499}\right)$. Find the value of x.

13. Following plots show Magnetization (M) vs Magnetising field (H) and Magnetic susceptibility (χ) vs temperature (T) graph :

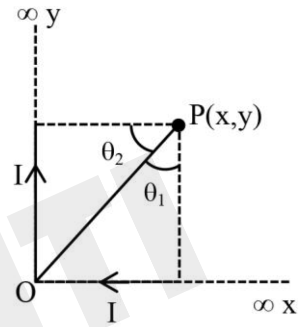


Which of the following combination will be represented by a diamagnetic material?

(1) (a), (c) (2) (a), (d)

(3) (b), (d) (4) (b), (c)

14 There are two infinitely long straight current carrying conductors and they are held at right angles to each other so that their common ends meet at the origin as shown in the figure given below. The ratio of current in both conductor is 1 : 1. The magnetic field at point P is ____.



(1) $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}+(x+y)\right]$

(2) $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}-(x+y)\right]$

(3) $\frac{\mu_0 Ixy}{4\pi}\left[\sqrt{x^2+y^2}-(x+y)\right]$

(4) $\frac{\mu_0 Ixy}{4\pi}\left[\sqrt{x^2+y^2}+(x+y)\right]$

August Attempt (EMI)

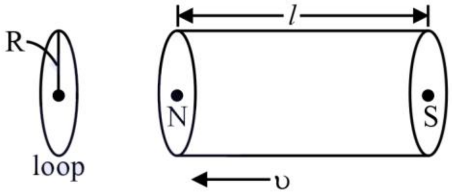
1. An inductor coil stores 64 J of magnetic field energy and dissipates energy at the rate of 640 W when a current of 8A is passed through it. If this coil is joined across an ideal battery, find the time constant of the circuit in seconds :

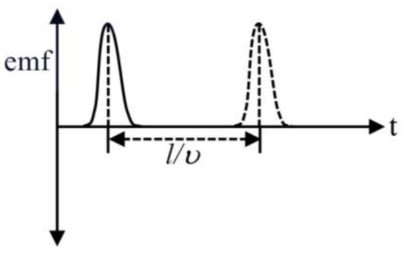
(1) 0.4 (2) 0.8 (3) 0.125 (4) 0.2

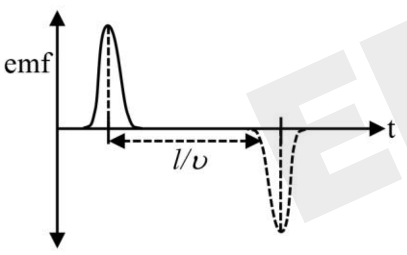
SOLUTION

2. A circular coil of radius 8.0 cm and 20 turns is rotated about its vertical diameter with an angular speed of 50 rad s^{-1} in a uniform horizontal magnetic field of 3.0×10^{-2} T. The maximum emf induced the coil will be .... $\times 10^{-2}$ volt (rounded off to the nearest integer)

3. A bar magnet is passing through a conducting loop of radius R with velocity υ. The radius of the bar magnet is such that it just passes through the loop. The induced e.m.f. in the loop can be represented by the approximate curve :



(1)


(2)


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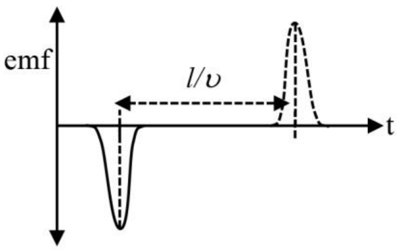
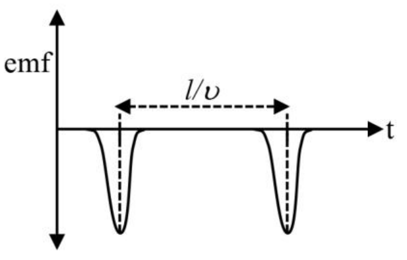
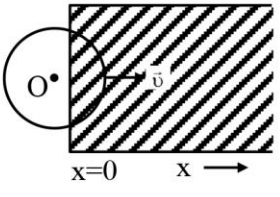


(4)


4. A constant magnetic field of 1 T is applied in the $x > 0$ region. A metallic circular ring of radius 1m is moving with a constant velocity of 1 m/s along the x-axis. At t = 0s, the centre of O of the ring is at x = – 1m. What will be the value of the induced emf in the ring at t = 1s? (Assume the velocity of the ring does not change.)

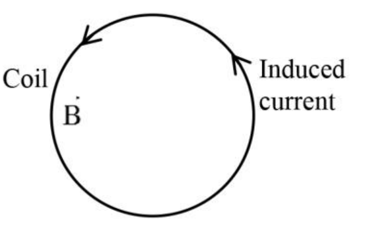


(1) 1 V
(2) 2π V
(3) 2 V
(4) 0 V

5. A small square loop of side 'a' and one turn is placed inside a larger square loop of side b and one turn (b >> a). The two loops are coplanar with their centres coinciding. If a current I is passed in the square loop of side 'b', then the coefficient of mutual inductance between the two loops is :

(1) $\frac{\mu_0}{4\pi} 8\sqrt{2} \frac{a^2}{b}$
(2) $\frac{\mu_0}{4\pi} \frac{8\sqrt{2}}{a}$
(3) $\frac{\mu_0}{4\pi} 8\sqrt{2} \frac{b^2}{a}$
(4) $\frac{\mu_0}{4\pi} \frac{8\sqrt{2}}{b}$

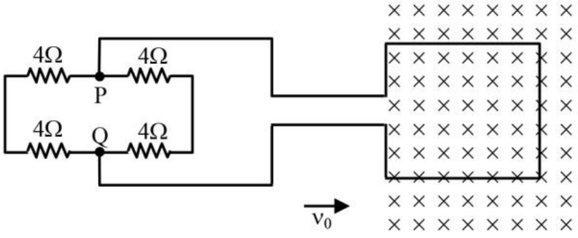
6. A coil is placed in a magnetic field $\vec{B}$ as shown below :



A current is induced in the coil because $\vec{B}$ is :
(1) Outward and decreasing with time
(2) Parallel to the plane of coil and decreasing with time
(3) Outward and increasing with time
(4) Parallel to the plane of coil and increasing with time

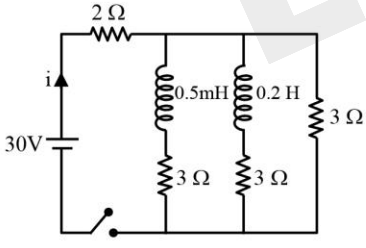
SOLUTION

7 A square loop of side 20 cm and resistance 1Ω is moved towards right with a constant speed v_0. The right arm of the loop is in a uniform magnetic field of 5T. The field is perpendicular to the plane of the loop and is going into it. The loop is connected to a network of resistors each of value 4Ω. What should be the value of v_0 so that a steady current of 2 mA flows in the loop ?



(1) 1 m/s (2) 1 cm/s
(3) 10^2 m/s (4) 10^{-2} cm/s

8. For the given circuit the current i through the battery when the key in closed and the steady state has been reached is__________.

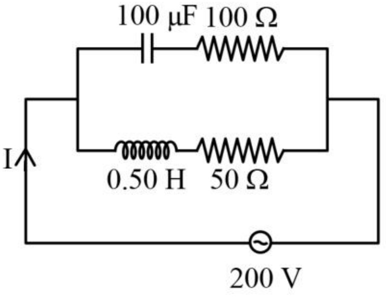


(1) 6 A (2) 25 A
(3) 10 A (4) 0 A

<u>August Attempt</u> (AC)

1. A series LCR circuit driven by 300 V at a frequency of 50 Hz contains a resistance R = 3 kΩ, an inductor of inductive reactance $X_L = 250\ \pi\Omega$ and an unknown capacitor. The value of capacitance to maximize the average power should be : (Take $\pi^2 = 10$)
(1) 4 μF (2) 25 μF (3) 400 μF (4) 40 μF

2. In the given circuit the AC source has $\omega = 100\ \text{rad s}^{-1}$. Considering the inductor and capacitor to be ideal, what will be the current I flowing through the circuit?



(1) 5.9 A (3) 0.94 A
(2) 4.24 A (4) 6 A

3. The alternating current is given by

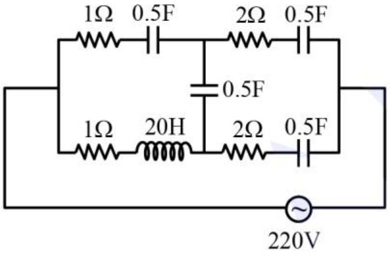
$$i = \left\{\sqrt{42}\sin\left(\frac{2\pi}{T}t\right) + 10\right\}A$$

The r.m.s. value of this current is .... A.

4. An ac circuit has an inductor and a resistor of resistance R in series, such that $X_L = 3R$. Now, a capacitor is added in series such that $X_C = 2R$. The ratio of new power factor with the old power factor of the circuit is $\sqrt{5}:x$. The value of x is _____.

5. In an ac circuit, an inductor, a capacitor and a resistor are connected in series with $X_L = R = X_C$. Impedance of this circuit is :
(1) $2R^2$ (2) Zero
(3) R (4) $R\sqrt{2}$

6. At very high frequencies, the effective impendance of the given circuit will be______Ω.



<u>SOLUTION</u>

ANSWER KEY

Feb Attempt *(Magnetism & EMI)*

1. 4
2. 1
3. 4
4. 2
5. 2
6. 144
7. 1

Feb Attempt (AC)

1. 900
2. 2000
3. 4
4. 2
5. 1
6. 1
7. 283

March Attempt *(Magnetism)*

1. 3
2. 3
3. 1
4. 2
5. 1
6. 1

March Attempt *(EMI & AC)*

1. 3
2. 3
3. 4
4. 3
5. 3
6. 2
7. 4
8. 2
9. 4
10. 1
11. 1
12. 3
13. 3

July Attempt *(Magnetism)*

1. 4
2. 2
3. 1
4. 2
5. 22
6. 2
7. 8
8. 3

July Attempt (EMI)

1. 3
2. 74
3. 80
4. 3
5. 60

July Attempt (AC)

1. 3
2. 4
3. 125
4. 3
5. 1
6. 1
7. 500
8. 1
9. 4

August Attempt *(Magnetism)*

1. 4
2. 1
3. 4
4. 543
5. 3
6. 2
7. 3
8. 4
9. 1
10. 1
11. 4
12. 250
13. 1
14. 1

August Attempt (EMI)

1. 4
2. 60
3. 3
4. 3
5. 1
6. 1
7. 2
8. 3

August Attempt (AC)

1. 1
2. Bonus
3. 11
4. 1
5. 3
6. 2

Following are Magnetism Questions from Feb Attempt 2021
Q1, Q3, Q4, Q5

1. **Assertion (A) :** In an uniform magnetic field, speed and energy remains the same for a moving charged particle.

Reason (R) : Moving charged particle experiences magnetic force perpendicular to its direction of motion.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A)

(B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A)

(C) (A) is true but (R) is false

(D) (A) is false but (R) is true.

2. The magnetic field at the centre of a circular coil of radius r, due to current I flowing through it, is B. The magnetic field at a point along the axis at a distance $\frac{r}{2}$ from the centre is :

(A) B/2 (B) 2B

(C) $\left(\frac{2}{\sqrt{5}}\right)^3 B$ (D) $\left(\frac{2}{\sqrt{3}}\right)^3 B$

3. The soft-iron is a suitable material for making an electromagnet. This is because soft-iron has :

(A) low coercively and high retentively

(B) low coercively and low permeability

(C) high permeability and low retentively

(D) high permeability and high retentively

4. A proton, a deuteron and an α-particle with same kinetic energy enter into a uniform magnetic field at right angle to magnetic field. The ratio of the radii of their respective circular paths is :

(A) $1:\sqrt{2}:\sqrt{2}$ (B) $1:1:\sqrt{2}$

(C) $\sqrt{2}:1:1$ (D) $1:\sqrt{2}:1$

5. A long straight wire with a circular cross-section having radius R, is carrying a steady current I. The current I is uniformly distributed across this cross-section. Then the variation of magnetic field due to current I with distance r (r < R) from its centre will be :-

(A) $B \propto r^2$ (B) $B \propto r$

(C) $B \propto \frac{1}{r^2}$ (D) $B \propto \frac{1}{r}$

6. **Statement – I** : Susceptibilities of paramagnetic and ferromagnetic substances increase with decrease in temperature.

Statement – II: Diamagnetism is a result of orbital motions of electrons developing magnetic moments opposite to the applied magnetic field.

Choose the **CORRECT** answer from the options given below : -

(A) Both statement – I and statement -II are true.

(B) Both statement – I and Statement – II are false.

(C) Statement – I is true but statement – II is false.

(D) Statement-I is false but Statement-II is true.

7. A long solenoid carrying a current produces a magnetic field B along its axis. If the current is doubled and the number of turns per cm is halved, the new value of magnetic field will be equal to

(A) B (B) 2 B

(C) 4 B (D) $\frac{B}{2}$

8. A proton and an alpha particle of the same speed enter in a uniform magnetic field which is acting perpendicular to their direction of motion. The ratio of the radius circular paths described by the alpha particle and proton is:

(A) 1 : 4 (B) 4 : 1

(C) 2 : 1 (D) 1 : 2

SOLUTION

9. A bar magnet having a magnetic moment of 2.0×10^5 JT^{-1}, is placed along the direction of uniform magnetic field of magnitude $B = 14 \times 10^{-5}$ T. The work done in rotating the magnet slowly through 60° from the direction of field is :

(A) 14 J (B) 8.4 J (C) 4 J (D) 1.4 J

10. Two 10 cm long, straight wires, each carrying a current of 5A are kept parallel to each other. If each wire experienced a force of 10^{-5} N, then separation between the wires is _________cm.

11. The susceptibility of a paramagnetic material is 99. The permeability of the material in Wb/A-m is : [Permeability of free space $\mu_0 = 4\pi \times 10^{-7} Wb/A-m$]

(A) $4\pi \times 10^{-7}$ (B) $4\pi \times 10^{-4}$

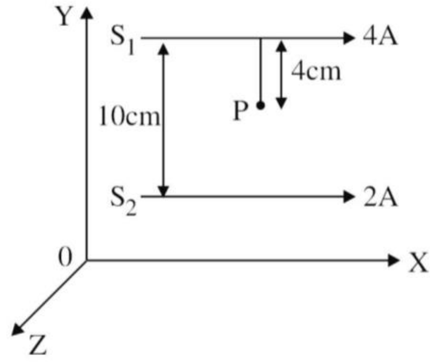
(C) $4\pi \times 10^{-5}$ (D) $4\pi \times 10^{-6}$

12. Two long parallel conductors S_1 and S_2 are separated by a distance 10 cm and carrying currents of 4A and 2A respectively. The conductors are placed along x-axis in X-Y plane. There is a point P located between the conductors (as shown in figure).

A charge particle of 3π coulomb is passing through the point P with velocity

$\vec{v} = (2\hat{i} + 3\hat{j})$m/s; where $\hat{i}$ & $\hat{j}$ represents unit vector along x & y axis respectively.

The force acting on the charge particle is $4\pi \times 10^{-5}(-x\hat{i} + 2\hat{j})$N. The value of x is :

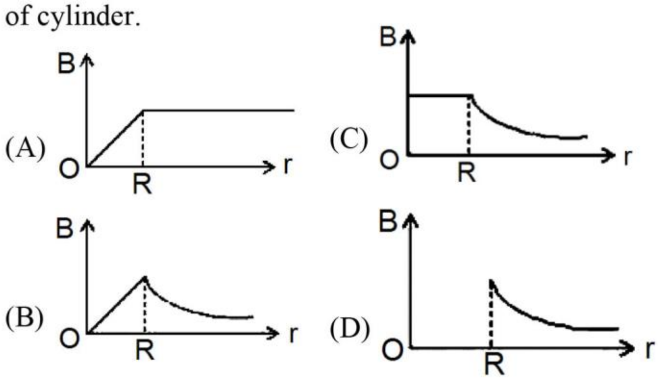


(A) 2 (B) 1

(C) 3 (D) –3

13. A deuteron and a proton moving with equal kinetic energy enter into to a uniform magnetic field at right angle to the field. If r_d and r_p are the radii of their circular paths respectively, then the ratio $\frac{r_d}{r_p}$ will be $\sqrt{x} : 1$ where x is ______ .

14. An infinitely long hollow conducting cylinder with radius R carries a uniform current along its surface. Choose the correct representation of magnetic field (B) as a function of radial distance (r) from the axis of cylinder.



15. A singly ionized magnesium atom (A24) ion is accelerated to kinetic energy 5 keV and is projected perpendicularly into a magnetic field B of the magnitude 0.5 T. The radius of path formed will be _____________ cm.

SOLUTION

16. The space inside a straight current carrying solenoid is filled with a magnetic material having magnetic susceptibility equal to 1.2×10^{-5}. What is fractional increase in the magnetic field inside solenoid with respect to air as medium inside the solenoid?

(A) 1.2×10^{-5} (B) 1.2×10^{-3}

(C) 1.8×10^{-3} (D) 2.4×10^{-5}

17. Two parallel, long wires are kept 0.20 m apart in vacuum, each carrying current of x A in the same direction. If the force of attraction per meter of each wire is $2\times10^{-6}\text{N}$, then the value of x is approximately:

(A) 1 (B) 2.4

(C) 1.4 (D) 2

18. A charged particle moves along circular path in a uniform magnetic field in a cyclotron. The kinetic energy of the charged particle increases to 4 times its initial value. What will be the ratio of new radius to the original radius of circular path of the charged particle :

(A) 1 : 1 (B) 1 : 2

(C) 2 : 1 (D) 1 : 4

19. At a certain place the angle of dip is 30° and the horizontal component of earth's magnetic field is 0.5 G. The earth's total magnetic field (in G), at that certain place, is :

(A) $\frac{1}{\sqrt{3}}$ (B) $\frac{1}{2}$

(C) $\sqrt{3}$ (D) 1

20. Two long current carrying conductors are placed parallel to each other at a distance of 8 cm between them. The magnitude of magnetic field produced at mid-point between the two conductors due to current flowing in them is 300 μT. The equal current flowing in the two conductors is :

(A) 30A in the same direction.

(B) 30A in the opposite direction.

(C) 60A in the opposite direction.

(D) 300A in the opposite direction.

21. **Statement I:** The electric force changes the speed of the charged particle and hence changes its kinetic energy: whereas the magnetic force does not change the kinetic energy of the charged particle.

Statement II: The electric force accelerates the positively charged particle perpendicular to the direction of electric field. The magnetic force accelerates the moving charged particle along the direction of magnetic field. In the light of the above statements, choose the most appropriate answer from the options given below:

(A) Both Statement I and Statement II are correct.

(B) Both Statement I and Statement II are incorrect.

(C) Statement I is correct but Statement II is incorrect.

(D) Statement I is incorrect but Statement II is

SOLUTION

Answer Key

1. A
2. C
3. C
4. D
5. B
6. A
7. A
8. C
9. A
10. 5
11. C
12. C
13. 2
14. D
15. 10
16. A
17. C
18. C
19. A
20. B
21. C

1. Two charged particles, having same kinetic energy, are allowed to pass through a uniform magnetic field perpendicular to the direction of motion. If the ratio of radii of their circular paths is 6 : 5 and their respective masses ratio is 9 : 4. Then, the ratio of their charges will be :

(A) 8 : 5 (B) 5 : 4
(C) 5 : 3 (D) 8 : 7

2. The magnetic moment of an electron (e) revolving in an orbit around nucleus with an orbital angular momentum is given by :

(A) $\vec{\mu}_L = \frac{e\vec{L}}{2m}$ (B) $\vec{\mu}_L = -\frac{e\vec{L}}{2m}$
(C) $\vec{\mu}_1 = -\frac{e\vec{L}}{m}$ (D) $\vec{\mu}_1 = \frac{2e\vec{L}}{m}$

3. The electric current in a circular coil of 2 turns produces a magnetic induction B_1 at its centre. The coil is unwound and is rewound into a circular coil of 5 turns and the same current produces a magnetic induction B_2 at its centre.

The ratio of $\frac{B_2}{B_1}$ is :

(A) $\frac{5}{2}$ (B) $\frac{25}{4}$
(C) $\frac{5}{4}$ (D) $\frac{25}{2}$

4. An electron with energy 0.1 keV moves at right angle to the earth's magnetic field of 1×10^{-4} Wbm^{-2}. The frequency of revolution of the electron will be
(Take mass of electron = 9.0×10^{-31} kg)

(A) 1.6×10^5 Hz (B) 5.6×10^5 Hz
(C) 2.8×10^6 Hz (D) 1.8×10^6 Hz

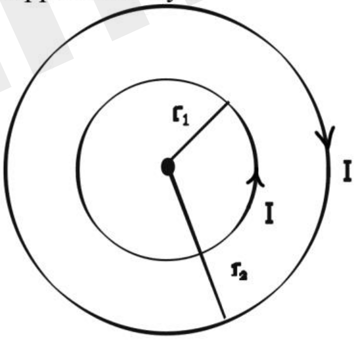
5. A charge particle is moving in a uniform magnetic field $(2\hat{i}+3\hat{j})$T. If it has an acceleration of $(\alpha\hat{i}-4\hat{j})\,m/s^2$, then the value of α will be

(A) 3 (B) 6
(C) 12 (D) 2

6. B_X and B_Y are the magnetic field at the centre of two coils of two coils X and Y respectively, each carrying equal current. If coil X has 200 turns and 20 cm radius and coil Y has 400 turns and 20 cm radius, the ratio of B_X and B_Y is :

(A) 1 : 1 (B) 1 : 2
(C) 2 : 1 (D) 4 : 1

7. Two concentric circular loops of radii r_1=30 cm and r_2=50 cm are placed in X-Y plane as shown in the figure. A current I = 7A is flowing through them in the direction as shown in figure. The net magnetic moment of this system of two circular loops is approximately :



(A) $\frac{7}{2}\hat{k}$ Am^2 (B) $-\frac{7}{2}\hat{k}$ Am^2
(C) $7\hat{k}$ Am^2 (D) $-7\hat{k}$ Am^2

8. A velocity selector consists of electric field $\vec{E} = E\hat{k}$ and magnetic field $\vec{B} = B\hat{j}$ with B=12 mT. The value E required for an electron of energy 728 eV moving along the positive x-axis to pass undeflected is :
(Given, mass of electron = 9.1×10^{-31}kg)

(A) 192 kVm^{-1} (B) 192 m Vm^{-1}
(C) 9600 kVm^{-1} (D) 16 kVm^{-1}

SOLUTION

9. Two bar magnets oscillate in a horizontal plane in earth's magnetic field with time periods of 3 s and 4 s respectively. If their moments of inertia are in the ratio of 3 : 2 then the ratio of their magnetic moments will e :

(A) 2 : 1 (B) 8 : 3

(C) 1 : 3 (D) 27 : 16

10. A magnet hung at 45° with magnetic meridian makes an angle of 60° with the horizontal. The actual value of the angle of dip is

(A) $\tan^{-1}\left(\sqrt{\frac{3}{2}}\right)$ (B) $\tan^{-1}\left(\sqrt{6}\right)$

(C) $\tan^{-1}\left(\sqrt{\frac{2}{3}}\right)$ (D) $\tan^{-1}\left(\sqrt{\frac{1}{2}}\right)$

11. A 1 m long copper wire carries a current of 1 A. If the cross section of the wire is 2.0 mm^2 and the resistivity of copper is $1.7 \times 10^{-8}\ \Omega$ m. the force experienced by moving electron in the wire is _______ $\times 10^{-23}$ N.

(charge on electron = 1.6×10^{-19} C)

12. A compass needle of oscillation magnetometer oscillates 20 times per minute at a place P of dip 30°. The number of oscillations per minute become 10 at another place Q of 60° dip. The ratio of the total magnetic field at the two places ($B_Q : B_P$) is:

(A) $\sqrt{3} : 4$ (B) $4 : \sqrt{3}$ (C) $\sqrt{3} : 2$ (D) $2 : \sqrt{3}$

13. A cyclotron is used to accelerate protons. If the operating magnetic field is 1.0 T and the radius of the cyclotron 'dees' is 60 cm, the kinetic energy of the accelerated protons in MeV will be :

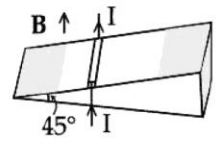
[use m_p = 1.6 $\times 10^{-27}$ kg, e = 1.6×10^{-19} C]

(A) 12 (B) 18

(C) 16 (D) 32

14. As shown in the figure, a metallic rod of linear density 0.45 kg m^{-1} is lying horizontally on a smooth incline plane which makes an angle of 45° with the horizontal. The minimum current flowing in the rod required to keep it stationary, when 0.15 T magnetic field is acting on it in the vertical upward direction, will be :

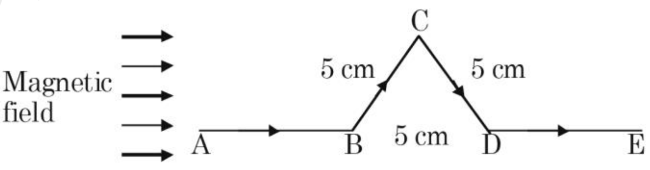
{Use g = 10 m/s^2}



(A) 30 A (B) 15 A

(C) 10 A (D) 3 A

15. A triangular shaped wire carrying 10A current is placed in a uniform magnetic field of 0.5T, as shown in figure. The magnetic force on segment CD is (Given BC = CD = BD = 5 cm).



(A) 0.126 N (B) 0.312 N

(C) 0.216 N (D) 0.245 N

16. The magnetic field at the center of current carrying circular loop is B_1. The magnetic field at a distance of $\sqrt{3}$ times radius of the given circular loop from the center on its axis is B_2. The value of B_1/B_2 will be

(A) 9 : 4 (B) $12 : \sqrt{5}$

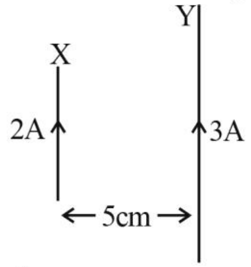
(C) 8 : 1 (D) $5 : \sqrt{3}$

SOLUTION

17. A closely wounded circular coil of radius 5 cm produces a magnetic field of 37.68×10^{-4} T at its center. The current through the coil is _________ A. [Given, number of turns in the coil is 100 and $\pi = 3.14$]

18. A wire of length 314 cm carrying current of 14 A is bent to form a circle. The magnetic moment of the coil is _______ A-m^2. [Given $\pi = 3.14$]

19. A wire X of length 50 cm carrying a current of 2 A is placed parallel to a long wire Y of length 5 m. The wire Y carries a current of 3 A. The distance between two wires is 5 cm and currents flow in the same direction. The force acting on the wire Y is :



(A) 1.2×10^{-5} N directed towards wire X.
(B) 1.2×10^{-4} N directed away from wire X.
(C) 1.2×10^{-4} N directed towards wire X.
(D) 2.4×10^{-5} N directed towards wire X.

20. The vertical component of the earth's magnetic field is 6×10^{-5} T at any place where the angle of dip is 37°. The earth's resultant magnetic field at that place will be (Given $\tan 37° = \frac{3}{4}$)

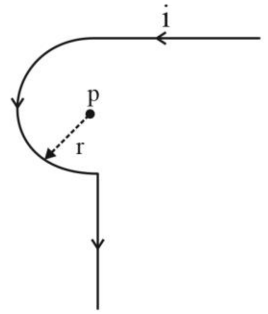
(A) 8×10^{-5} T (B) 6×10^{-5} T
(C) 5×10^{-4} T (D) 1×10^{-4} T

SOLUTION

ANSWER KEY

1. B
2. B
3. B
4. C
5. B
6. B
7. B
8. A
9. B
10. A
11. 136
12. A
13. B
14. A
15. C
16. C
17. 3
18. 11
19. A
20. D

1. Find the magnetic field at the point P in figure. The curved portion is a semicircle connected to two long straight wires.



(1) $\frac{\mu_0 i}{2r}\left(1+\frac{2}{\pi}\right)$ (2) $\frac{\mu_0 i}{2r}\left(1+\frac{1}{\pi}\right)$

(3) $\frac{\mu_0 i}{2r}\left(\frac{1}{2}+\frac{1}{2\pi}\right)$ (4) $\frac{\mu_0 i}{2r}\left(\frac{1}{2}+\frac{1}{\pi}\right)$

2. A charge particle of 2 μC accelerated by a potential difference of 100V enters a region of uniform magnetic field of magnitude 4 mT at right angle to the direction of field. The charge particle completes semicircle of radius 3 cm inside magnetic field. The mass of the charge particle is______ $\times 10^{-18}$ kg.

3. As shown in the figure, a long straight conductor with semicircular arc of radius $\frac{\pi}{10}$ m is carrying current I = 3A. The magnitude of the magnetic field. at the center O of the arc is:
(The permeability of the vacuum = $4\pi \times 10^{-7}$ NA^{-2})

(1) 6μT (2) 1μT
(3) 4μT (4) 3μT

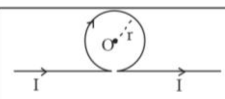
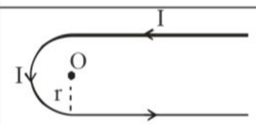
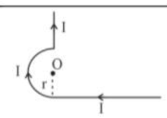
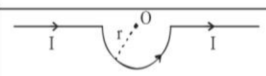
4. Two long straight wires P and Q carrying equal current 10A each were kept parallel to each other at 5 cm distance. Magnitude of magnetic force experienced by 10 cm length of wire P is F_1. If distance between wires is halved and currents on them are doubled, force F_2 on 10 cm length of wire P will be :
(1) 8 F_1 (2) 10 F_1
(3) $F_1/8$ (4) $F_1/10$

5. A circular loop of radius r is carrying current I A. The ratio of magnetic field at the centre of circular loop and at a distance r from the center of the loop on its axis is :
(1) $1:3\sqrt{2}$ (2) $3\sqrt{2}:2$
(3) $2\sqrt{2}:1$ (4) $1:\sqrt{2}$

6. A long solenoid is formed by winding 70 turns cm^{-1}. If 2.0 A current flows, then the magnetic field produced inside the solenoid is ______________ ($\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1})
(1) 1232×10^{-4} T
(2) 176×10^{-4} T
(3) 352×10^{-4} T
(4) 88×10^{-4} T

7. A single turn current loop in the shape of a right angle triangle with sides 5 cm, 12 cm, 13 cm is carrying a current of 2A. The loop is in a uniform magnetic field of magnitude 0.75 T whose direction is parallel to the current in the 13 cm side of the loop. The magnitude of the magnetic force on the 5 cm side will be $\frac{x}{130}$ N. The value of x is

8.

	List – I (Current configuration)		List – II (Magnetic field at point O)
A		I.	$B_0 = \frac{\mu_0 I}{4\pi r}[\pi+2]$
B		II.	$B_0 = \frac{\mu_0}{4}\frac{I}{r}$
C		III.	$B_0 = \frac{\mu_0 I}{2\pi r}[\pi-1]$
D		IV	$B_0 = \frac{\mu_0 I}{4\pi r}[\pi+1]$

Choose the correct answer from the option given below:
(1) A-III, B-IV, C-I, D-II
(2) A-I, B-III, C-IV, D-II
(3) A-III, B-I, C-IV, D-II
(4) A-II, B-I, C-IV, D-III

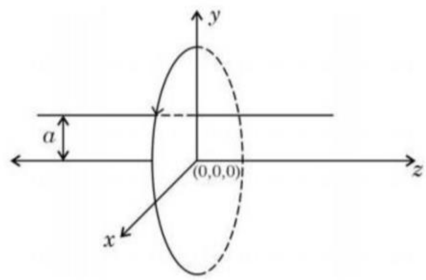
SOLUTION

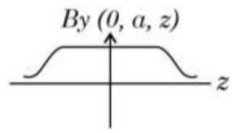
9. A solenoid of 1200 turns is wound uniformly in a single layer on a glass tube 2 m long and 0.2 m in diameter. The magnetic intensity at the center of the solenoid when a current of 2 A flows through it is:
(1) 2.4×10^3 A m^{-1}
(2) 1.2×10^3 A m^{-1}
(3) 1 A m^{-1}
(4) 2.4×10^{-3} A m^{-1}

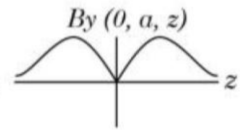
10. For a moving coil galvanometer, the deflection in the coil is 0.05 rad when a current of 10 mA is passed through it. If the torsional constant of suspension wire is 4.0×10^{-5} Nm rad^{-1}, the magnetic field is 0.01 T and the number of turns in the coil is 200, the area of each turn (in cm^2) is :
(1) 2.0 (2) 1.0
(3) 1.5 (4) 0.5

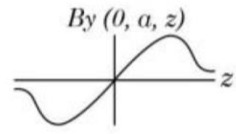
11. Two long parallel wires carrying currents 8A and 15 A in opposite directions are placed at a distance of 7 cm from each other. A point P is at equidistant from both the wires such that the lines joining the point P to the wires are perpendicular to each other. The magnitude of magnetic field at P is ____ $\times 10^{-6}$ T. (Given : $\sqrt{2}$ = 1.4)

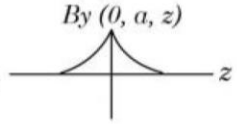
12 A single current carrying loop of wire carrying current I flowing in anticlockwise direction seen from +ve z direction and lying in xy plane in shown in figure. The plot of $\hat{j}$ component of magnetic field (By) at a distance 'a' (less than radius of the coil) and on yz plane vs z coordinate look like



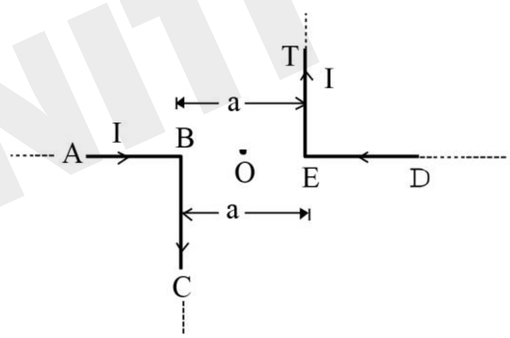
(1)


(2)


(3)


(4)


13. The magnitude of magnetic induction at mid-point O due to current arrangement as shown in Fig will be :



(1) $\frac{\mu_0 I}{2\pi a}$ (2) 0
(3) $\frac{\mu_0 I}{4\pi a}$ (4) $\frac{\mu_0 I}{\pi a}$

14. The electric current in a circular coil of four turns produces a magnetic induction 32 T at its centre. The coil is unwound and is rewound into a circular coil of single turn, the magnetic induction at the centre of the coil by the same current will be :
(1) 8T (2) 4T
(3) 2T (4) 16T

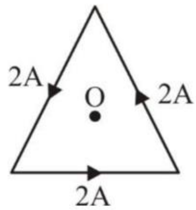
SOLUTION

15. The magnetic moments associated with two closely wound circular coils A and B of radius $r_A = 10$ cm and $r_B = 20$ cm respectively are equal if: (Where N_A, I_A and N_B, I_B are number of turn and current of A and B respectively)

(1) $2N_AI_A = N_BI_B$ (2) $N_A = 2N_B$

(3) $N_AI_A = 4N_BI_B$ (4) $4N_AI_A = N_BI_B$

16 As shown in the figure, a current of 2A flowing in an equilateral triangle of side $4\sqrt{3}$ cm. The magnetic field at the centroid O of the triangle is :

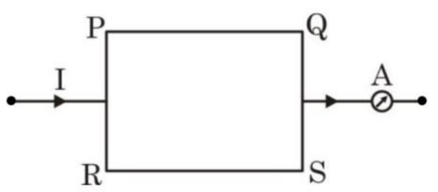


(Neglect the effect of earth's magnetic field.)

(1) $4\sqrt{3}\times10^{-4}$T (2) $4\sqrt{3}\times10^{-5}$T

(3) $\sqrt{3}\times10^{-4}$T (4) $3\sqrt{3}\times10^{-5}$T

17. A current carrying rectangular loop PQRS is made of uniform wire. The length PR = QS = 5 cm and PQ = RS = 100 cm. If ammeter current reading changes from I to 2I, the ratio of magnetic forces per unit length on the wire PQ due to wire RS in the two cases respectively $f_{PQ}^{I} : f_{PQ}^{2I}$ is :



(1) 1 : 2 (2) 1 : 4

(3) 1 : 5 (4) 1 : 3

18. A bar magnet with a magnetic moment 5.0 Am^2 is placed in parallel position relative to a magnetic field of 0.4 T. The amount of required work done in turning the magnet form parallel to antiparallel position relative to the field direction is ________.

(1) 4 J (2) 1 J

(3) 2 J (4) Zero

19. A rod with circular cross-section area 2 cm^2 and length 40 cm is wound uniformly with 400 turns of an insulated wire. If a current of 0.4 A flows in the wire windings, the total magnetic flux produced inside windings is $4\pi\times10^{-6}$ Wb. The relative permeability of the rod is

(Given : Permeability of vacuum $\mu_0 = 4\pi\times10^{-7}NA^{-2}$)

(1) 12.5 (2) $\frac{32}{5}$

(3) 125 (4) $\frac{5}{16}$

20. A long conducting wire having a current I flowing through it, is bent into a circular coil of N turns. Then it is bent into a circular coil of n turns. The magnetic field is calculated at the centre of coils in both the cases. The ratio of the magnetic field in first case to that of second case is:

(1) N : n (2) $n^2 : N^2$

(3) $N^2 : n^2$ (4) n : N

21. The number of turns of the coil of a moving coil galvanometer is increased in order to increase current sensitivity by 50%. The percentage change in voltage sensitivity of the galvanometer will be :

(1) 100% (2) 50%

(3) 75% (4) 0%

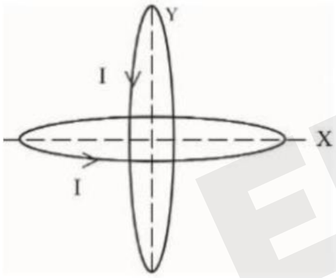
SOLUTION

Moving Charges/MEC

1. 3
2. 144
3. 4
4. 1
5. 3
6. 2
7. 9
8. 3
9. 2
10. 2
11. 68
12. 3
13. 4
14. 3
15. 3
16. 4
17. 2
18. 1
19. 4
20. 3
21. 4

1. A long straight wire of circular cross-section (radius a) is carrying steady current I. The current I is uniformly distributed across this cross-section. The magnetic field is
(1) Zero in the region r < a and inversely proportional to r in the region r > a
(2) Inversely proportional to r in the region r < a and uniform throughout in the region r > a
(3) Directly proportional to r in the region r < a and inversely proportional to r in the region r > a
(4) Uniform in the region r < a and inversely proportional to distance r from the axis, in the region r > a

2. Two identical circular wires of radius 20 cm and carrying current $\sqrt{2}$ A are placed in perpendicular planes as shown in figure. The net magnetic field at the centre of the circular wire is ________ $\times 10^{-8}$ T. (Take $\pi = 3.14$)



3. A proton with a kinetic energy of 2.0 eV moves into a region of uniform magnetic field of magnitude $\frac{\pi}{2}\times10^{-3}$ T. The angle between the direction of magnetic field and velocity of proton is 60°. The pitch of the helical path taken by the proton is________cm.
(Take, mass of proton = 1.6×10^{-27} kg and Charge on proton = 1.6×10^{-19} C).

SOLUTION

4. A charge particle moving in magnetic field B, has the components of velocity along B as well as perpendicular to B. The path of the charge particle will be
(1) helical path with the axis perpendicular to the direction of magnetic field B
(2) straight along the direction of magnetic field B
(3) helical path with the axis along magnetic field B
(4) circular path

5. Certain galvanometers have a fixed core made of non magnetic metallic material. The function of this metallic material is
(1) to oscillate the coil in magnetic field for longer period of time
(2) to bring the coil to rest quickly
(3) to produce large deflecting torque on the coil
(4) to make the magnetic field radial

6. The magnetic intensity at the centre of a long current carrying solenoid is found to be $1.6\times10^{3}\ \text{Am}^{-1}$. If the number of turns is 8 per cm, then the current flowing through the solenoid is______A.

7. **Assertion A:** Electromagnets are made of soft iron.
Reason R: Soft iron has high permeability and low retentivity.
In the light of above, statements, choose the most appropriate answer from the options given below.
(1) A is not correct but R is correct
(2) Both A and R are correct and R is the correct explanation of A
(3) Both A and R are correct but R is NOT the correct explanation of A
(4) A is correct but R is not correct

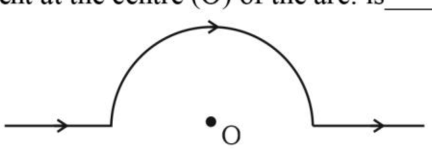
8. The ratio of magnetic field at the centre of a current carrying coil of radius r to the magnetic field at distance r from the centre of coil on its axis is $\sqrt{x}:1$. The value of x is ____________

9. **Statement I :** If the number of turns in the coil of a moving coil galvanometer is doubled then the current sensitivity becomes double.
Statement II : Increasing current sensitivity of a moving coil galvanometer by only increasing the number of turns in the coil will also increase its voltage sensitivity in the same ratio:
In the light of the above statement, choose the correct answer from the options given below :
(1) Statement I is false but Statement II is true
(2) Both Statement I and Statement II are true
(3) Both Statement I and Statement II are false
(4) Statement I is true but Statement II is false

10. The current required to be passed through a solenoid of 15 cm length and 60 turns in order to demagnetise a bar magnet of magnetic intensity $2.4\times10^{3}\ \text{Am}^{-1}$ is __________ A.

11. **Statement I:** For diamagnetic substance, $-1 \le \chi < 0$, where χ is the magnetic susceptibility.
Statement II: Diamagnetic substances when placed in an external magnetic field, tend to move from stronger to weaker part of the field.
In the light of the above statements, choose the correct answer from the options given below.
(1) Both Statement I and Statement II are false.
(2) Both Statement I and Statement II are true.
(3) Statement I is incorrect but Statement II is true.
(4) Statement I is correct but Statement II is false.

12. A straight wire carrying a current of 14 A is bent into a semicircular are of radius 2.2 cm as shown in the figure. The magnetic field produced by the current at the centre (O) of the arc. is_____$\times10^{-4}$T



13. The free space inside a current carrying toroid is filled with a material of susceptibility 2×10^{-2}. The percentage increase in the value of magnetic field inside the toroid will be
(1) 2% (2) 0.2%
(3) 0.1% (4) 1%

14. The current sensitivity of moving coil galvanometer is increased by 25%. This increase is achieved only by changing in the number of turns of coils and area of cross section of the wire while keeping the resistance of galvanometer coil constant. The percentage change in the voltage sensitivity will be:
(1) +25% (2) – 50%
(3) Zero (4) – 25%

15. An electron is allowed to move with constant velocity along the axis of current carrying straight solenoid.
A. The electron will experience magnetic force along the axis of the solenoid.
B. The electron will not experience magnetic force.
C. The electron will continue to move along the axis of the solenoid.
D. The electron will be accelerated along the axis of the solenoid.
E. The electron will follow parabolic path–inside the solenoid.
Choose the correct answer from the options given below:
(1) B, C and D only (2) B and C only
(3) A and D only (4) B and E only

SOLUTION

16. **Statement I :** The diamagnetic property depends on temperature.

Statement II : The included magnetic dipole moment in a diamagnetic sample is always opposite to the magnetizing field.

In the light of given statement, choose the correct answer from the options given below:

(1) Statement I is incorrect but Statement II is true

(2) Both Statement I and Statement II are true.

(3) Both Statement I and Statement II are false.

(4) Statement I is correct but Statement II is false.

17. A compass needle oscillates 20 times per minute at a place where the dip is 30° and 30 times per minute where the dip is 60°. The ratio of total magnetic field due to the earth at two place respectively is $\frac{4}{\sqrt{x}}$. The value of x is

18. The source of time varying magnetic field may be

(A) a permanent magnet

(B) an electric field changing linearly with time

(C) direct current

(D) a decelerating charge particle

(E) an antenna fed with a digital signal

Choose the correct answer from the options given below:

(1) (D) only

(2) (C) and (E) only

(3) (A) only

(4) (B) and (D) only

19. An electron is moving along the positive x-axis. If the uniform magnetic field is applied parallel to the negative z-axis. then

A. The electron will experience magnetic force along positive y-axis

B. The electron will experience magnetic force along negative y-axis

C. The electron will not experience any force in magnetic field

D. The electron will continue to move along the positive x-axis

E. The electron will move along circular path in magnetic field

Choose the correct answer from the options given below :

(1) B and E only (2) A and E only

(3) C and D only (4) B and D only

20. A straight wire AB of mass 40 g and length 50 cm is suspended by a pair of flexible leads in uniform magnetic field of magnitude 0.40 T as shown in the figure. The magnitude of the current required in the wire to remove the tension in the supporting leads is ________A. (Take $g = 10\ ms^{-2}$).

21. An electron in a hydrogen atom revolves around its nucleus with a speed of $6.76 \times 10^6\ ms^{-1}$ in an orbit of radius 0.52 A°. The magnetic field produced at the nucleus of the hydrogen atom is __________T.

SOLUTION

Moving Charges & MEC

1. 3
2. 628
3. 40
4. 3
5. 2
6. 2
7. 2
8. 8
9. 4
10. 6
11. 2
12. 2
13. 1
14. 1
15. 2
16. 1
17. 243
18. 1
19. 1
20. 2
21. 40

1. A regular polygon of 6 sides is formed by bending a wire of length 4π meter. If an electric current of $4\pi\sqrt{3}$ A is flowing through the sides of the polygon, the magnetic field at the centre of the polygon would be $x \times 10^{-7}$ T. The value of x is ____.

2. A moving coil galvanometer has 100 turns and each turn has an area of 2.0 cm^2. The magnetic field produced by the magnet is 0.01 T and the deflection in the coil is 0.05 radian when a current of 10 mA is passed through it. The torsional constant of the suspension wire is $x \times 10^{-5}$ N-m/rad. The value of x is___.

3. A proton moving with a constant velocity passes through a region of space without any change in its velocity. If $\vec{E}$ and $\vec{B}$ represent the electric and magnetic fields respectively, then the region of space may have :

(A) $E = 0, B = 0$ (B) $E = 0, B \neq 0$

(C) $E \neq 0, B = 0$ (D) $E \neq 0, B \neq 0$

Choose the most appropriate answer from the options given below :

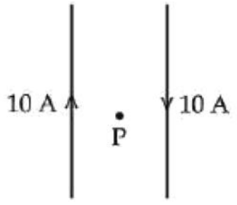
(1)(A), (B) and (C) only

(2) (A), (C) and (D) only

(3) (A), (B) and (D) only

(4) (B), (C) and (D) only

4. Two long, straight wires carry equal currents in opposite directions as shown in figure. The separation between the wires is 5.0 cm. The magnitude of the magnetic field at a point P midway between the wires is ____ μT
(Given : $\mu_0 = 4\pi \times 10^{-7}$ TmA^{-1})

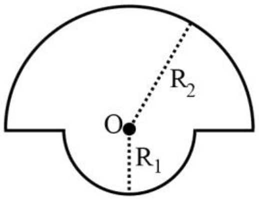


5. A current of 200 μA deflects the coil of a moving coil galvanometer through 60^0. The current to cause deflection through $\frac{\pi}{10}$ radian is :

(1) 30 μA (2) 120 μA

(3) 60 μA (4) 180 μA

6. The magnetic field at the centre of a wire loop formed by two semicircular wires of radii $R_1 = 2\pi$ m, and $R_2 = 4\pi$ m carrying current I = 4A as per figure given below is $\alpha \times 10^{-7}$ T. The value of α is ______. (Centre O is common for all segments)



7. The magnetic potential due to a magnetic dipole at a point on its axis situated at a distance of 20 cm from its center is 1.5×10^{-5}Tm. The magnetic moment of the dipole is __________ Am^2.
(Given : $\frac{\mu_0}{4\pi} = 10^{-7}TmA^{-1}$)

8. Two particles X and Y having equal charges are being accelerated through the same potential difference. Thereafter they enter normally in a region of uniform magnetic field and describes circular paths of radii R_1 and R_2 respectively. The mass ratio of X and Y is :

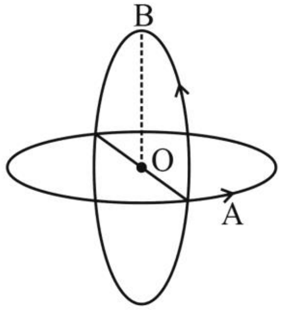
(1) $\left(\frac{R_2}{R_1}\right)^2$ (2) $\left(\frac{R_1}{R_2}\right)^2$

(3) $\left(\frac{R_1}{R_2}\right)$ (4) $\left(\frac{R_2}{R_1}\right)$

9. A charge of 4.0 μC is moving with a velocity of 4.0×10^6 ms^{-1} along the positive y-axis under a magnetic field $\vec{B}$ of strength $\left(2\hat{k}\right)$ T. The force acting on the charge is $x\hat{i}$ N . The value of x is __.

SOLUTION - CLICK

10. Two insulated circular loop A and B radius 'a' carrying a current of 'I' in the anti clockwise direction as shown in figure. The magnitude of the magnetic induction at the centre will be :



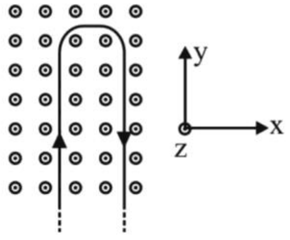
(1) $\frac{\sqrt{2}\mu_0 I}{a}$ (2) $\frac{\mu_0 I}{2a}$

(3) $\frac{\mu_0 I}{\sqrt{2}a}$ (4) $\frac{2\mu_0 I}{a}$

11. The horizontal component of earth's magnetic field at a place is $3.5\times10^{-5}T$. A very long straight conductor carrying current of $\sqrt{2}A$ in the direction from South east to North West is placed. The force per unit length experienced by the conductor is ……… × 10^{-6} N/m.

12. The current of 5A flows in a square loop of sides 1 m is placed in air. The magnetic field at the centre of the loop is $X\sqrt{2}\times10^{-7}$T. The value of X is_____.

13. A rigid wire consists of a semicircular portion of radius R and two straight sections. The wire is partially immerged in a perpendicular magnetic field B = $B_0\ \hat{j}$ as shown in figure. The magnetic force on the wire if it has a current i is :



(1) $-iBR\hat{j}$ (2) $2iBR\hat{j}$

(3) $iBR\hat{j}$ (4) $-2iBR\hat{j}$

14. An electron moves through a uniform magnetic field $\vec{B}=B_0\hat{i}+2B_0\hat{j}$ T. At a particular instant of time, the velocity of electron is $\vec{u}=3\hat{i}+5\hat{j}$ m/s. If the magnetic force acting on electron is $\vec{F}=5ek$ N, where e is the charge of electron, then the value of B_0 is ____ T.

15. A uniform magnetic field of 2×10^{-3}T acts along positive Y-direction. A rectangular loop of sides 20 cm and 10 cm with current of 5 A is Y-Z plane. The current is in anticlockwise sense with reference to negative X axis. Magnitude and direction of the torque is :

(1) 2×10^{-4}N – m along positive Z –direction

(2) 2×10^{-4}N – m along negative Z-direction

(3) 2×10^{-4}N – m along positive X-direction

(4) 2×10^{-4}N – m along positive Y-direction

16. Two circular coils P and Q of 100 turns each have same radius of π cm. The currents in P and R are 1 A and 2 A respectively. P and Q are placed with their planes mutually perpendicular with their centers coincide. The resultant magnetic field induction at the center of the coils is $\sqrt{x}$ mT, where x =_________.

[Use $\mu_0 = 4\pi\times10^{-7}$ TmA^{-1}]

SOLUTION - CLICK

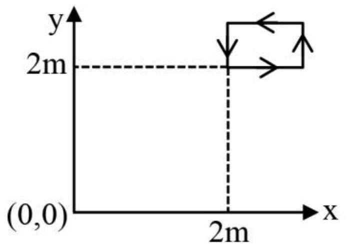
Answer Key

1. 72
2. 4
3. 3
4. 160
5. 3
6. 3
7. 6
8. 2
9. 32
10. 3
11. 35
12. 40
13. 4 (although in question there is typing error)
14. 5
15. 2
16. 20

SOLUTION - CLICK

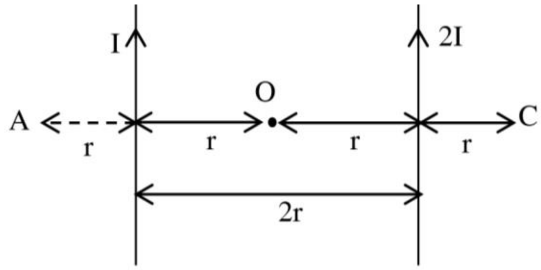
1. An electron is projected with uniform velocity along the axis inside a current carrying long solenoid. Then :
(1) the electron will be accelerated along the axis.
(2) the electron will continue to move with uniform velocity along the axis of the solenoid.
(3) the electron path will be circular about the axis.
(4) the electron will experience a force at 45° to the axis and execute a helical path.

2. The magnetic field existing in a region is given by $\vec{B} = 0.2(1+2x)\hat{k}T$. A square loop of edge 50 cm carrying 0.5 A current is placed in x-y plane with its edges parallel to the x-y axes, as shown in figure. The magnitude of the net magnetic force experienced by the loop is______ mN.



3. The magnetic moment of a bar magnet is 0.5 Am^2. It is suspended in a uniform magnetic field of 8×10^{-2} T. The work done in rotating it from its most stable to most unstable position is :
(1) 16×10^{-2} J
(2) 8×10^{-2} J
(3) 4×10^{-2} J
(4) Zero

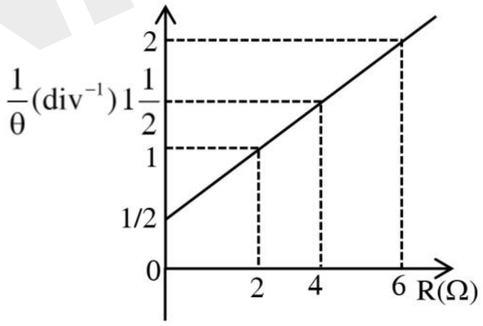
4. Two parallel long current carrying wire separated by a distance 2r are shown in the figure. The ratio of magnetic field at A to the magnetic field produced at C is $\frac{x}{7}$. The value of x is ___.



5. In a co-axial straight cable, the central conductor and the outer conductor carry equal currents in opposite directions. The magnetic field is zero.
(1) inside the outer conductor
(2) in between the two conductors
(3) outside the cable
(4) inside the inner conductor

6. A 2A current carrying straight metal wire of resistance 1 Ω, resistivity 2×10^{-6} Ωm, area of cross-section 10 mm^2 and mass 500 g is suspended horizontally in mid air by applying a uniform magnetic field $\vec{B}$. The magnitude of B is .... $\times 10^{-1}$ T (given, g = 10 m/s^2)

7. In the experiment to determine the galvanometer resistance by half-deflection method, the plot of $\frac{1}{\theta}$ vs the resistance (R) of the resistance box is shown in the figure. The figure of merit of the galvanometer is .... $\times 10^{-1}$ A/division. [The source has emf 2V]

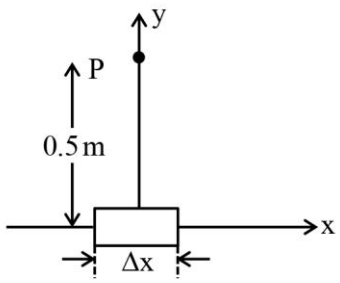


8. The electrostatic force $(\vec{F}_1)$ and magnetic force $(\vec{F}_2)$ acting on a charge q moving with velocity v can be written :
(1) $\vec{F}_1 = q\vec{V}.\vec{E}$, $\vec{F}_2 = q(\vec{B}.\vec{V})$
(2) $\vec{F}_1 = q\vec{B}$, $\vec{F}_2 = q(\vec{B} \times \vec{V})$
(3) $\vec{F}_1 = q\vec{E}$, $\vec{F}_2 = q(\vec{V} \times \vec{B})$
(4) $\vec{F}_1 = q\vec{E}$, $\vec{F}_2 = q(\vec{B} \times \vec{V})$

SOLUTION - CLICK

9. A solenoid of length 0.5 m has a radius of 1 cm and is made up of 'm' number of turns. It carries a current of 5A. If the magnitude of the magnetic field inside the solenoid is 6.28×10^{-3} T, then the value of m is :

10. An element $\Delta l = \Delta x \hat{i}$ is placed at the origin and carries a large current I = 10A. The magnetic field on the y-axis at a distance of 0.5 m from the elements Δx of 1 cm length is :



(1) 4×10^{-8} T (2) 8×10^{-8} T

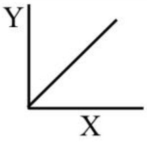
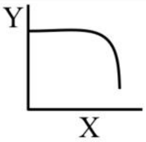
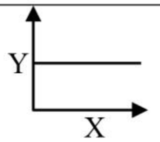
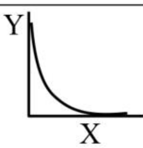
(3) 12×10^{-8} T (4) 10×10^{-8} T

11. A circular coil having 200 turns, 2.5×10^{-4} m^2 area and carrying 100 μA current is placed in a uniform magnetic field of 1 T. Initially the magnetic dipole moment $(\vec{M})$ was directed along $\vec{B}$. Amount of work, required to rotate the coil through 90° from its initial orientation such that $\vec{M}$ becomes perpendicular to $\vec{B}$, is __________ μJ.

13. A coil having 100 turns, area of 5×10^{-3}m^2, carrying current of 1 mA is placed in uniform magnetic field of 0.20 T such a way that plane of coil is perpendicular to the magnetic field. The work done in turning the coil through 90° is ______ μJ.

SOLUTION - CLICK

12.

List-I (Y vs X)		**List-II (Shape of Graph)**	
(A)	Y = magnetic susceptibility X = magnetising field	(I)	
(B)	Y = magnetic field X = distance from centre of a current carrying wire for x < a (where a=radius of wire)	(II)	
(C)	Y = magnetic field X = distance from centre of a current carrying wire for x > a (where a = radius of wire)	(III)	
(D)	Y= magnetic field inside solenoid X = distance from center	(IV)	

Choose the correct answer from the options given below :

(1) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)
(2) (A)-(I), (B)-(III), (C)-(II), (D)-(IV)
(3) (A)-(IV), (B)-(I), (C)-(III), (D)-(II)
(4) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

14. Paramagnetic substances:

A. align themselves along the directions of external magnetic field.

B. attract strongly towards external magnetic field.

C. has susceptibility little more than zero.

D. move from a region of strong magnetic field to weak magnetic field.

Choose the **most appropriate** answer from the options given below:

(1) A, B, C, D (2) B, D Only

(3) A, B, C Only (4) A, C Only

15. An electron with kinetic energy 5 eV enters a region of uniform magnetic field of 3 μT perpendicular to its direction. An electric field E is applied perpendicular to the direction of velocity and magnetic field. The value of E, so that electron moves along the same path, is_______ NC^{-1}.
(Given, mass of electron = 9×10^{-31} kg, electric charge = 1.6×10^{-19}C)

16. A long straight wire of radius a carries a steady current I. The current is uniformly distributed across its cross section. The ratio of the magnetic field at $\frac{a}{2}$ and 2a from axis of the wire is :
(1) 1 : 4 (2) 4 : 1
(3) 1 : 1 (4) 3 : 4

17. The coercivity of a magnet is 5×10^3 A/m. The amount of current required to be passed in a solenoid of length 30 cm and the number of turns 150, so that the magnet gets demagnetised when inside the solenoid is …………A.

18. A square loop of edge length 2 m carrying current of 2 A is placed with its edges parallel to the x-y axis. A magnetic field is passing through the x-y plane and expressed as $\vec{B} = B_0(1+4x)\hat{k}$, where B_0 = 5 T. The net magnetic force experienced by the loop is _______ N.

19. A proton and a deutron (q= +e, m = 2.0u) having same kinetic energies enter a region of uniform magnetic field $\vec{B}$, moving perpendicular to $\vec{B}$. The ratio of the radius r_d of deutron path to the radius r_p of the proton path is :
(1) 1 : 1 (2) $1:\sqrt{2}$
(3) $\sqrt{2}:1$ (4) 1 : 2

20. A straight magnetic strip has a magnetic moment of 44 Am^2. If the strip is bent in a semicircular shape, its magnetic moment will be ………. Am^2.
(Given $\pi = \frac{22}{7}$)

SOLUTION - CLICK

Answer Key

1. 2
2. 50
3. 2
4. 5
5. 3
6. 5
7. 5
8. 3
9. 500
10. 1
11. 5
12. 1
13. 100
14. 4
15. 4
16. 3
17. 10
18. 160
19. 3
20. 28

SOLUTION - CLICK

1. Choose the correct option relating wavelengths of differnet parts of electromagnetic wave spectrum

(a) $\lambda_{\text{x-rays}} < \lambda_{\text{micro waves}} < \lambda_{\text{radio waves}} < \lambda_{\text{visible}}$

(b) $\lambda_{\text{visible}} > \lambda_{\text{x-rays}} > \lambda_{\text{radio waves}} > \lambda_{\text{micro waves}}$

(c) $\lambda_{\text{radio waves}} > \lambda_{\text{micro waves}} > \lambda_{\text{visible}} > \lambda_{\text{x-rays}}$

(d) $\lambda_{\text{visible}} < \lambda_{\text{micro waves}} < \lambda_{\text{radio waves}} < \lambda_{\text{x-rays}}$

2. The correct match between the entries in column I and column II are

I	II
Radiation	**Wavelength**
(A) Microwave	(i) 100m
(B) Gamma rays	(ii) 10^{-15}
(C) A.M. radio waves	(iii) 10^{-10} m
(D) X-rays	(iv) 10^{-3} m

(a) (A)-(ii), (B)-(i), (C)-(iv), (D)-(iii)
(b) (A)-(i), (B)-(iiii), (C)-(iv), (D)-(ii)
(c) (A)-(iii), (B)-(ii), (C)-(i), (D)-(iv)
(d) (A)-(iv), (B)-(ii), (C)-(i), (D)-(iii)

3. In a plane electromagnetic wave, the directions of electric field and magnetic field are represented by $\hat{k}$ and $2\hat{i}-2\hat{j}$, respectively. What is the unit vector along direction of propagation of the wave.

(a) $\frac{1}{\sqrt{2}}(\hat{i}+\hat{j})$ (b) $\frac{1}{\sqrt{5}}(\hat{i}+2\hat{j})$

(c) $\frac{1}{\sqrt{5}}(2\hat{i}+\hat{j})$ (d) $\frac{1}{\sqrt{2}}(\hat{j}+\hat{k})$

4. An electron is constrained to move along the y-axis with a speed of 0.1 c (c is the speed of light) in the presence of electromagnetic wave, whose electric field is

$\vec{E} = 30\hat{j}\sin(1.5\times10^{7}t - 5\times10^{-2}x)$ V/m.

The maximum magnetic force experienced by the electron will be

(given $c = 3\times10^8$ ms^{-1} and electron charge $= 1.6\times10^{-19}$ C)

(a) 1.6×10^{-19} N (b) 4.8×10^{-19} N
(c) 3.2×10^{-18} N (d) 2.4×10^{-18} N

5. A plane electromagnetic wave, has frequency of 2.0×10^{10} Hz and its energy density is 1.02×10^{-8} J/m^3 in vacuum. The amplitude of the magnetic field of the wave is close to ($\frac{1}{4\pi\varepsilon_0} = 9\times10^9\frac{Nm^2}{C^2}$ and speed of light $= 3\times10^8$ ms^{-1})

(a) 190 nT (b) 160 nT
(c) 150 nT (d) 180 nT

6. The magnetic field of a plane electromagnetic wave is $\vec{B} = 3\times10^{-8}\sin[200\pi(y+ct)]\hat{i}$ T

where $c = 3\times10^8$ ms^{-1} is the speed of light. The corresponding electric field is

(a) $\vec{E} = -10^{-6}\sin[200\pi(y+ct)]\hat{k}$ V/m
(b) $\vec{E} = -9\sin[200\pi(y+ct)]\hat{k}$ V/m
(c) $\vec{E} = 9\sin[200\pi(y+ct)]\hat{k}$ V/m
(d) $\vec{E} = 3\times10^{-8}\sin[200\pi(y+ct)]\hat{k}$ V/m

7. A plane electromagnetic wave of frequency 25 GHz is propagating in vacuum along the z-direction. At a particular point in space and time, the magnetic field is given by $\vec{B} = 5\times10^{-8}\hat{j}$ T. The corresponding electric field $\vec{E}$ is (speed of light $c = 3\times10^8$ ms^{-1})

(a) $-1.66\times10^{-16}\hat{i}$ V/m (b) $1.66\times10^{-16}\hat{i}$ V/m
(c) $-15\hat{i}$ V/m (d) $15\hat{i}$ V/m

8. For a plane electromagnetic wave, the magnetic field at a point x and time t is

$\vec{B}(x,t) = [1.2\times10^{-7}\sin(0.5\times10^3x+1.5\times10^{11}t)\hat{k}]$ T

The instantaneous electric field $\vec{E}$ corresponding to $\vec{B}$ is (speed of light $c = 3\times10^8$ ms^{-1})

(a) $\vec{E}(x,t) = [36\sin(0.5\times10^3x+1.5\times10^{11}t)\hat{k}]\frac{\text{V}}{\text{m}}$

(b) $\vec{E}(x,t) = [-36\sin(0.5\times10^3x+1.5\times10^{11}t)\hat{j}]\frac{\text{V}}{\text{m}}$

(c) $\vec{E}(x,t) = [36\sin(1\times10^3x+0.5\times10^{11}t)\hat{j}]\frac{\text{V}}{\text{m}}$

(d) $\vec{E}(x,t) = [36\sin(1\times10^3x+1.5\times10^{11}t)\hat{j}]\frac{\text{V}}{\text{m}}$

9. If the magnetic field in a plane electromagnetic wave is given by $\vec{B} = 3\times10^{-8}\sin(1.6\times10^3x+48\times10^{10}t)\hat{j}$ T, then what will be expression for electric field

(a) $\vec{E} = 9\sin(1.6\times10^3x+48\times10^{10}t)\hat{k}$ V/m
(b) $\vec{E} = 60\sin(1.6\times10^3x+48\times10^{10}t)\hat{k}$ V/m
(c) $\vec{E} = 3\times10^{-8}\sin(1.6\times10^3x+48\times10^{10}t)\hat{i}$ V/m
(d) $\vec{E} = 3\times10^{-8}\sin(1.6\times10^3x+48\times10^{10}t)\hat{j}$ V/m

10. The electric field of a plane electromagnetic wave propagating along the x direction in vacuum is $\vec{E} = E_0\hat{j}\cos(\omega t - kx)$. The magnetic field $\vec{B}$, at the moment $t = 0$ is

(a) $\vec{B} = \frac{E_0}{\sqrt{\mu_0\in_0}}\cos(kx)\hat{j}$ (b) $\vec{B} = \frac{E_0}{\sqrt{\mu_0\in_0}}\cos(kx)\hat{k}$

(c) $\vec{B} = E_0\sqrt{\mu_0\in_0}\cos(kx)\hat{k}$ (d) $\vec{B} = E_0\sqrt{\mu_0\in_0}\cos(kx)\hat{j}$

11. The electric field of a plane electromagnetic wave is given by

$\vec{E} = E_0(\hat{x}+\hat{y})\sin(kz-\omega t)$

Its magnetic field will be given by

(a) $\frac{E_0}{c}(\hat{x}+\hat{y})\cos(kz-\omega t)$ (b) $\frac{E_0}{c}(-\hat{x}+\hat{y})\sin(kz-\omega t)$

(c) $\frac{E_0}{c}(\hat{x}-\hat{y})\sin(kz-\omega t)$ (d) $\frac{E_0}{c}(\hat{x}+\hat{y})\sin(kz-\omega t)$

SOLUTION

12. A plane electromagnetic wave is propagating, along the direction $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$, with its polarization along the direction $\hat{k}$. The correct form of the magnetic field of the wave would be (here B_0 is an appropriate constant)

(a) $B_0\frac{\hat{i}-\hat{j}}{\sqrt{2}}\cos\left(\omega t-k\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$ (b) $B_0\frac{\hat{j}-\hat{i}}{\sqrt{2}}\cos\left(\omega t+k\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

(c) $B_0\frac{\hat{i}+\hat{j}}{\sqrt{2}}\cos\left(\omega t-k\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$ (d) $B_0\hat{k}\cos\left(\omega t-k\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

13. The electric fields of two plane electromagnetic plane waves in vacuum are given by

$\vec{E}_1=E_0\hat{j}\cos(\omega t-kx)$ and $\vec{E}_2=E_0\hat{k}\cos(\omega t-ky)$

At $t=0$, a particle of charge q is at origin with a velocity $\vec{v}=0.8c\hat{j}$ (c is the speed of light in vaccum). The instantaneous force experienced by the particle is

(a) $E_0q(0.8\hat{i}-\hat{j}+0.4\hat{k})$ (b) $E_0q(0.4\hat{i}-3\hat{j}+0.8\hat{k})$

(c) $E_0q(-0.8\hat{i}+\hat{j}+\hat{k})$ (d) $E_0q(0.8\hat{i}+\hat{j}+0.2\hat{k})$

14. The electric field of a plane electromagnetic wave is given by

$\vec{E}=E_0\frac{\hat{i}+\hat{j}}{\sqrt{2}}\cos(kz+\omega t)$

At $t=0$, a positively charged particle is at the point $(x,y,z)=(0,0,\pi/k)$. If its instantneous velocity at $(t=0)$ is $v_0\hat{k}$, the force acting on it due to the wave is

(a) zero (b) parallel to $\hat{k}$

(c) antiparallel to $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$ (d) parallel to $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$

SOLUTION

ANSWER KEY

1. c
2. d
3. a
4. b
5. b
6. b
7. d
8. b
9. a
10. c
11. b
12. a
13. d
14. c

Following are EM Waves Questions

1. Feb Attempt – Q7, Q8
2. March Attempt – Q1, Q2, Q4, Q5, Q7
3. July Attempt – Q1, Q3, Q4, Q6, Q7
4. Aug Attempt – Q1, Q4, Q6, Q7, Q8, Q10

Feb Attempt

1. If the source of light used in a Young's double slit experiment is changed from red to violet :
(1) consecutive fringe lines will come closer.
(2) the central bright fringe will become a dark fringe.
(3) the fringes will become brighter.
(4) the intensity of minima will increase.

2. In a Young's double slit experiment, the width of the one of the slit is three times the other slit. The amplitude of the light coming from a slit is proportional to the slit-width. Find the ratio of the maximum to the minimum intensity in the interference pattern.
(1) 1 : 4 (2) 3 : 1 (3) 4 : 1 (4) 2 : 1

3. An unpolarized light beam is incident on the polarizer of a polarization experiment and the intensity of light beam emerging from the analyzer is measured as 100 Lumens. Now, if the analyzer is rotated around the horizontal axis (direction of light) by 30° in clockwise direction, the intensity of emerging light will be _______ Lumens.

4. Consider the diffraction pattern obtained from the sunlight incident on a pinhole of diameter 0.1μm. If the diameter of the pinhole is slightly increased, it will affect the diffraction pattern such thtat :
(1) its size decreases, and intensity decreases
(2) its size increases, and intensity increases
(3) its size increases, but intensity decreases
(4) its size decreases, but intensity increases

5. Two coherent light sources having intensity in the ratio 2x produce an interference pattern. The ratio $\frac{I_{max}-I_{min}}{I_{max}+I_{min}}$ will be :
(1) $\frac{2\sqrt{2x}}{x+1}$ (2) $\frac{\sqrt{2x}}{2x+1}$
(3) $\frac{\sqrt{2x}}{x+1}$ (4) $\frac{2\sqrt{2x}}{2x+1}$

6. In a Young's double slit experiment two slits are separated by 2 mm and the screen is placed one meter away. When a light of wavelength 500 nm is used, the fringe separation will be:
(1) 0.25 mm (2) 0.50 mm
(3) 0.75 mm (4) 1 mm

7. An electromagnetic wave of frequency 5 GHz, is travelling in a medium whose relative electric permittivity and relative magnetic permeability both are 2. Its velocity in this medium is ________ $\times 10^7$ m/s.

8. A radiation is emitted by 1000 W bulb and it generates an electric field and magnetic field at P, placed at a distance of 2 m. The efficiency of the bulb is 1.25%. The value of peak electric field at P is x × 10^{-1} V/m. Value of x is_. (Rounded-off to the nearest integer)
[Take $\varepsilon_0 = 8.85 \times 10^{-12}$ $C^2N^{-1}m^{-2}$, $c = 3 \times 10^8$ ms^{-1}]

March Attempt

1. A plane electromagnetic wave of frequency 500 MHz is travelling in vacuum along y-direction. At a particular point in space and time, $\vec{B} = 8.0 \times 10^{-8}\hat{z}T$. The value of electric field at this point is :
(speed of light = 3 × 10^8 ms^{-1})
$\hat{x}, \hat{y}, \hat{z}$ are unit vectors along x, y and z direction.
(1) $-24\hat{x}$ V/m (2) $2.6\hat{x}$ V/m
(3) $24\hat{x}$ V/m (4) $-2.6\hat{y}$ V/m

SOLUTION

2. For an electromagnetic wave travelling in free space, the relation between average energy densities due to electric (U_e) and magnetic (U_m) fields is :
(1) $U_e = U_m$ (2) $U_e > U_m$
(3) $U_e < U_m$ (4) $U_e \neq U_m$

3. A fringe width of 6 mm was produced for two slits separated by 1 mm apart. The screen is placed 10 m away. The wavelength of light used is 'x' nm. The value of 'x' to the nearest integer is ______.

4. The electric field intensity produced by the radiation coming from a 100 W bulb at a distance of 3m is E. The electric field intensity produced by the radiation coming from 60 W at the same distance is $\sqrt{\frac{x}{5}}E$. Where the value of x =_________.

5. A plane electromagnetic wave of frequency 100 MHz is travelling in vacuum along the x-direction. At a particular point in space and time, $\vec{B} = 2.0 \times 10^{-8}\hat{k}T$. (where, $\hat{k}$ is unit vector along z-direction) What is $\vec{E}$ at this point ?
(1) $0.6\hat{j}$ V/m (2) $6.0\hat{k}$ V/m
(3) $6.0\hat{j}$ V/m (4) $0.6\hat{k}$ V/m

6. In Young's double slit arrangement, slits are separated by a gap of 0.5 mm, and the screen is placed at a distance of 0.5 m from them. The distance between the first and the third bright fringe formed when the slits are illuminated by a monochromatic light of 5890 Å is :-
(1) 1178×10^{-9} m (2) 1178×10^{-6} m
(3) 1178×10^{-12} m (4) 5890×10^{-7} m

7. A plane electromagnetic wave propagating along y-direction can have the following pair of electric field $(\vec{E})$ and magnetic field $(\vec{B})$ components.
(1) E_y, B_y or E_z, B_z (3) E_x, B_z or E_z, B_x
(2) E_y, B_x or E_x, B_y (4) E_x, B_y or E_y, B_x

July Attempt

1. AC voltage $V(t) = 20 \sin\omega t$ of frequency 50 Hz is applied to a parallel plate capacitor. The separation between the plates is 2 mm and the area is 1 m^2. The amplitude of the oscillating displacement current for the applied AC voltage is _______. [Take $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m]
(1) 21.14 μA (2) 83.37 μA
(3) 27.79 μA (4) 55.58 μA

2. With what speed should a galaxy move outward with respect to earth so that the sodium-D line at wavelength 5890 Å is observed at 5896 Å ?
(1) 306 km/sec (2) 322 km/sec
(3) 296 km/sec (4) 336 km/sec

3. In an electromagnetic wave the electric field vector and magnetic field vector are given as $\vec{E} = E_0\,\hat{i}$ and $\vec{B} = B_0\hat{k}$ respectively. The direction of propagation of electromagnetic wave is along :
(1) $(\hat{k})$
(2) $\hat{j}$
(3) $(-\hat{k})$
(4) $(-\hat{j})$

4. Intensity of sunlight is observed as 0.092 Wm^{-2} at a point in free space. What will be the peak value of magnetic field at that point ?
($\varepsilon_0 = 8.85 \times 10^{-12} C^2N^{-1}m^{-2}$)
(1) 2.77×10^{-8} T (2) 1.96×10^{-8} T
(3) 8.31 T (4) 5.88 T

5. In the Young's double slit experiment, the distance between the slits varies in time as $d(t) = d_0 + a_0 \sin\omega t$; where d_0, ω and a_0 are constants. The difference between the largest fringe width and the smallest fringe width obtained over time is given as :
(1) $\frac{2\lambda D(d_0)}{(d_0^2 - a_0^2)}$ (2) $\frac{2\lambda D a_0}{(d_0^2 - a_0^2)}$
(3) $\frac{\lambda D}{d_0^2}a_0$ (4) $\frac{\lambda D}{d_0 + a_0}$

SOLUTION

6. A linearly polarized electromagnetic wave in vacuum is

$E = 3.1\cos\left[(1.8)z - (5.4\times10^6)t\right]\hat{i}\ N/C$

is incident normally on a perfectly reflecting wall at z = a. Choose the correct option

(1) The wavelength is 5.4 m

(2) The frequency of electromagnetic wave is 54×10^4 Hz.

(3) The transmitted wave will be $3.1\cos\left[(1.8)z - (5.4\times10^6)t\right]\hat{i}\ N/C$

(4) The reflected wave will be $3.1\cos\left[(1.8)z + (5.4\times10^6)t\right]\hat{i}\ N/C$

7. The relative permittivity of distilled water is 81. The velocity of light in it will be :

(Given $\mu_r = 1$)

(1) 4.33×10^7 m/s (2) 2.33×10^7 m/s

(3) 3.33×10^7 m/s (4) 5.33×10^7 m/s

8. In Young's double slit experiment, if the source of light changes from orange to blue then :

(1) the central bright fringe will become a dark fringe.

(2) the distance between consecutive fringes will decrease.

(3) the distance between consecutive fringes will increase.

(4) the intensity of the minima will increase.

9. The difference in the number of waves when yellow light propagates through air and vacuum columns of the same thickness is one. The thickness of the air column is ______ mm. [Refractive index of air = 1.0003, wavelength of yellow light in vacuum = 6000 Å]

August Attempt

1. The electric field in a plane electromagnetic wave is given by

$$\vec{E} = 200\cos\left[\left(\frac{0.5\times10^3}{m}\right)x - \left(1.5\times10^{11}\frac{rad}{s}\times t\right)\right]\frac{V}{m}\hat{j}$$

If this wave falls normally on a perfectly reflecting surface having an area of 100 cm^2. If the radiation pressure exerted by the E.M. wave on the surface during a 10 minute exposure is $\frac{x}{10^9}\frac{N}{m^2}$. Find the value of x.

2. White light is passed through a double slit and interference is observed on a screen 1.5 m away. The separation between the slits is 0.3 mm. The first violet and red fringes are formed 2.0 mm and 3.5 mm away from the central white fringes. The difference in wavelengths of red and voilet light is .... nm.

3. A source of light is placed in front of a screen. Intensity of light on the screen is I. Two Polaroids P_1 and P_2 are so placed in between the source of light and screen that the intensity of light on screen is I/2. P_2 should be rotated by an angle of .... (degrees) so that the intensity of light on the screen becomes $\frac{3I}{8}$.

4. Electric field in a plane electromagnetic wave is given by $E = 50 \sin(500x - 10 \times 10^{10}t)$ V/m

The velocity of electromagnetic wave in this medium is :

(Given C = speed of light in vacuum)

(1) $\frac{3}{2}C$ (2) C

(3) $\frac{2}{3}C$ (4) $\frac{C}{2}$

5. The light waves from two coherent sources have same intensity $I_1 = I_2 = I_0$. In interference pattern the intensity of light at minima is zero.What will be the intensity of light at maxima ?

(1) I_0 (2) $2 I_0$

(3) $5 I_0$ (4) $4 I_0$

6. A plane electromagnetic wave with frequency of 30 MHz travels in free space. At particular point in space and time, electric field is 6 V/m. The magnetic field at this point will be $x \times 10^{-8}$ T. The value of x is _____.

7. The electric field in an electromagnetic wave is given by $E = (50\ NC^{-1}) \sin\omega(t - x/c)$

The energy contained in a cylinder of volume V is 5.5×10^{-12} J. The value of V is __________ cm^3.

$\left(\text{given } \epsilon_0 = 8.8\times10^{-12}C^2N^{-1}m^{-2}\right)$

SOLUTION

8. The magnetic field vector of an electromagnetic wave is given by $B = B_o \frac{\hat{i}+\hat{j}}{\sqrt{2}} \cos(kz - \omega t)$; where $\hat{i}, \hat{j}$ represents unit vector along x and y-axis respectively. At t = 0 s, two electric charges q_1 of 4π coulomb and q_2 of 2π coulomb located at $\left(0,0,\frac{\pi}{k}\right)$ and $\left(0,0,\frac{3\pi}{k}\right)$, respectively, have the same velocity of $0.5\, c\,\hat{i}$, (where c is the velocity of light). The ratio of the force acting on charge q_1 to q_2 is :-

(1) $2\sqrt{2} : 1$ (2) $1 : \sqrt{2}$

(3) $2 : 1$ (4) $\sqrt{2} : 1$

9. In a Young's double slit experiment, the slits are separated by 0.3 mm and the screen is 1.5 m away from the plane of slits. Distance between fourth bright fringes on both sides of central bright is 2.4 cm. The frequency of light used is_____$\times 10^{14}$ Hz.

10. Electric field of plane electromagnetic wave propagating through a non–magnetic medium is given by $E = 20\cos(2 \times 10^{10}\ t - 200x)$ V/m. The dielectric constant of the medium is equal to :
(Take $\mu_r = 1$)

(1) 9 (2) 2 (3) $\frac{1}{3}$ (4) 3

11. The width of one of the two slits in a Young's double slit experiment is three times the other slit. If the amplitude of the light coming from a slit is proportional to the slit-width, the ratio of minimum to maximum intensity in the interference pattern is x : 4 where x is _______.

SOLUTION

ANSWER KEY

Feb Attempt

1. 1
2. 3
3. 75
4. 4
5. 4
6. 1
7. 15
8. 137

March Attempt

1. 1
2. 1
3. 600
4. 3
5. 3
6. 2
7. 3

July Attempt

1. 3
2. 1
3. 4
4. 1
5. 2
6. 4
7. 3
8. 2
9. 2

August Attempt

1. 354
2. 300
3. 30
4. 3
5. 4
6. 2
7. 500
8. 3
9. 5
10. 1
11. 1

Following are EM Waves Questions

1. Feb Attempt – Q7, Q8
2. March Attempt – Q1, Q2, Q4, Q5, Q7
3. July Attempt – Q1, Q3, Q4, Q6, Q7
4. Aug Attempt – Q1, Q4, Q6, Q7, Q8, Q10

1. A plane electromagnetic wave travels in a medium of relative permeability 1.61 and relative permittivity 6.44. If magnitude of magnetic intensity is 4.5×10^{-2} Am^{-1} at a point, what will be the approximate magnitude of electric field intensity at that point ?
(Given : permeability of free space $\mu_0 = 4\pi \times 10^{-7}$ NA^{-2}, speed of light in vacuum $c = 3 \times 10^8$ ms^{-1})
(A) 16.96 Vm^{-1} (B) 2.25×10^{-2} Vm^{-1}
(C) 8.48 Vm^{-1} (D) 6.75×10^6 Vm^{-1}

2. An electric bulb is rated as 200 W. What will be the peak magnetic field at 4 m distance produced by the radiations coming from this bulb? Consider this bulb as a point source with 3.5% efficiency.
(A) 1.19×10^{-8} T (B) 1.71×10^{-8} T
(C) 0.84×10^{-8} T (D) 3.36×10^{-8} T

3. The electric field in an electromagnetic wave is given by $E = 56.5 \sin\omega(t - x/c)\, NC^{-1}$. Find the intensity of the wave if it is propagating along x-axis in the free space. (Given $\varepsilon_0 = 8.85 \times 10^{-12} C^2N^{-1}m^{-2}$)
(A) 5.65 Wm^{-2} (B) 4.24 Wm^{-2}
(C) 1.9×10^{-7} Wm^{-2} (D) 56.5 Wm^{-2}

4. The electromagnetic waves travel in a medium at a speed of 2.0×10^8 m/s. The relative permeability of the medium is 1.0. The relative permittivity of the medium will be:
(A) 2.25 (B) 4.25
(C) 6.25 (D) 8.25

5. If electric field intensity of a uniform plane electro magnetic wave is given as
$E = -301.6 \sin(kz - \omega t)\hat{a}_x + 452.4 \sin(kz - \omega t)\hat{a}_y \frac{V}{m}$
Then, magnetic intensity H of this wave in Am^{-1} will be:'
[Given: Speed of light in vacuum $c = 3 \times 10^8$ ms^{-1}, permeability of vacuum $\mu_0 = 4\pi \times 10^{-7}$ NA^{-2}]
(A) $+0.8\sin(kz - \omega t)\hat{a}_y + 0.8\sin(kz - \omega t)\hat{a}_x$
(B) $+1.0 \times 10^{-6} \sin(kz - \omega t)\hat{a}_y + 1.5 \times 10^{-6}(kz - \omega t)\hat{a}_x$
(C) $-0.8\sin(kz - \omega t)\hat{a}_y - 1.2\sin(kz - \omega t)\hat{a}_x$
(D) $-1.0 \times 10^{-6} \sin(kz - \omega t)\hat{a}_y - 1.5 \times 10^{-6} \sin(kz - \omega t)\hat{a}_x$

6. Which is the correct ascending order of wavelengths?
(A) $\lambda_{visible} < \lambda_{X-ray} < \lambda_{gamma\text{-}ray} < \lambda_{microwave}$
(B) $\lambda_{gamma\text{-}ray} < \lambda_{X-ray} < \lambda_{visible} < \lambda_{microwave}$
(C) $\lambda_{X\text{-}ray} < \lambda_{gamma\text{-}ray} < \lambda_{visible} < \lambda_{microwave}$
(D) $\lambda_{microwave} < \lambda_{visible} < \lambda_{gamma\text{-}ray} < \lambda_{X\text{-}ray}$

7. **List** – I List – II

	List-I		List-Ii
(a)	Ultravoilet rays	(i)	Study crystal structure
(b)	Microwaves	(ii)	Greenhouse effect
(c)	Infrared waves	(iii)	Sterilizing surgical instrument
(d)	X-rays	(iv)	Rader system

Choose the correct answer from the options given below :
(A) (a) – (iii), (b) – (iv), (c) – (ii), (d) – (i)
(B) (a) – (iii), (b) – (i), (c) – (ii), (d) – (iv)
(C) (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)
(D) (a) – (iii), (b) – (iv), (c) – (i), (d) – (ii)

SOLUTION

8. Given below are two statements:

Statement I : A time varying electric field is a source of changing magnetic field and vice-versa. Thus a disturbance in electric or magnetic field creates EM waves.

Statement II : In a material medium. The EM wave travels with speed $v = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$.

In the light of the above statements, choose the correct answer from the options given below:

(A) Both statement I and statement II are true.

(B) Both statement I and statement II are false.

(C) Statement I is correct but statement II is false.

(D) Statement I is incorrect but statement II is true.

9. A radar sends an electromagnetic signal of electric field (E_0) = 2.25 V/m and magnetic field $(B_0) = 1.5 \times 10^{-8}$ T which strikes a target on line of sight at a distance of 3 km in a medium. After that, a pail of signal (echo) reflects back towards the radar vit1i same velocity and by same path. If the signal was transmitted at time t_0 from radar. then after how much time echo will reach to the radar?

(A) 2.0×10^{-5}s (B) 4.0×10^{-5}s

(C) 1.0×10^{-5}s (D) 8.0×10^{-5}s

10. An EM wave propagating in x-direction has a wavelength of 8 mm. The electric field vibrating y-direction has maximum magnitude of 60 Vm^{-1}. Choose the correct equations for electric and magnetic fields if the EM wave is propagating in vacuum :

(A) $E_y = 60\sin\left[\frac{\pi}{4}\times10^3\left(x-3\times10^8 t\right)\right]\hat{j}Vm^{-1}$

$B_z = 2\sin\left[\frac{\pi}{4}\times10^3\left(x-3\times10^8 t\right)\right]\hat{k}T$

(B) $E_y = 60\sin\left[\frac{\pi}{4}\times10^3\left(x-3\times10^8 t\right)\right]\hat{j}Vm^{-1}$

$B_z = 2\times10^{-7}\sin\left[\frac{\pi}{4}\times10^3\left(x-3\times10^8 t\right)\right]\hat{k}T$

(C) $E_y = 2\times10^{-7}\sin\left[\frac{\pi}{4}\times10^3\left(x-3\times10^8 t\right)\right]\hat{j}Vm^{-1}$

$B_z = 60\sin\left[\frac{\pi}{4}\times10^3\left(x-3\times10^8 t\right)\right]\hat{k}T$

(D) $E_y = 2\times10^{-7}\sin\left[\frac{\pi}{4}\times10^4\left(x-4\times10^8 t\right)\right]\hat{j}Vm^{-1}$

$B_z = 60\sin\left[\frac{\pi}{4}\times10^4\left(x-4\times10^8 t\right)\right]\hat{k}T$

12. The intensity of the light from a bulb incident on a surface is 0.22 W/m^2. The amplitude of the magnetic field in this light-wave is______$\times10^{-9}$ T.

(Given : Permittivity of vacuum $\epsilon_0 = 8.85\times10^{-12} C^2N^{-1}m^{-2}$, speed of light in vacuum $c = 3\times10^8 ms^{-1}$)

12. The displacement current of 4.425 μA is developed in the space between the plates of parallel plate capacitor when voltage is changing at a rate of 10^6 Vs^{-1}. The area of each plate of the capacitor is 40 cm^2. The distance between each plate of the capacitor is $x \times 10^{-3}$m. The value of x is,

(Permittivity of free space, $E_0 = 8.85\times10^{-12} C^2 N^{-1} m^{-2}$)

SOLUTION

Answer Key

1. C
2. B
3. B
4. A
5. C
6. B
7. A
8. C
9. B
10. B
11. 43
12. 8

1. The rms value of conduction current in a parallel plate capacitor is 6.9 μA. The capacity of this capacitor, if it is connected to 230 V ac supply with an angular frequency of 600 rad/s, will be :
(A) 5 pF (B) 50 pF
(C) 100 pF (D) 200 pF

2. Light wave traveling in air along x-direction is given by $E_y = 540 \sin \pi \times 10^4(x - ct)\ Vm^{-1}$. Then, the peak value of magnetic field of wave will be (Given $c = 3 \times 10^8\ ms^{-1}$)
(A) 18×10^{-7} T (B) 54×10^{-7} T
(C) 54×10^{-8} T (D) 18×10^{-8} T

3. The magnetic field of a plane electromagnetic wave is given by
$$\vec{B} = 2\times10^{-8}\sin\left(0.5\times10^{3}x + 1.5\times10^{11}t\right)\hat{j}T$$
The amplitude of the electric field would be
(A) $6Vm^{-1}$ along x-axis
(B) $3Vm^{-1}$ along z-axis
(C) $6Vm^{-1}$ along z-axis
(D) $2\times10^{-8}Vm^{-1}$ along z-axis

4. The oscillating magnetic field in a plane electromagnetic wave is given by $B_y = 5 \times 10^{-6} \sin 1000\pi\ (5x - 4 \times 10^8\ t)T$. The amplitude of electric field will be :
(A) $15 \times 10^2\ Vm^{-1}$ (B) $5 \times 10^{-6}\ Vm^{-1}$
(C) $16 \times 10^{12}\ Vm^{-1}$ (D) $4 \times 10^2\ Vm^{-1}$

5. A beam of light travelling along X-axis is described by the electric field $E_y = 900 \sin \omega(t–x/c)$. The ratio of electric force to magnetic force on a charge q moving along Y-axis with a speed of $3 \times 10^7\ ms^{-1}$ will be :
[Given speed of light = $3 \times 10^8\ ms^{-1}$]
(A) 1 : 1 (B) 1 : 10
(C) 10 : 1 (D) 1 : 2

6. Identify the correct statements from the following descriptions of various properties of electromagnetic waves.
A. In a plane electromagnetic wave electric field and magnetic field must be perpendicular to each other and direction of propagation of wave should be along electric field or magnetic field.
B. The energy in electromagnetic wave is divided equally between electric and magnetic fields.
C. Both electric field and magnetic field are parallel to each other and perpendicular to the direction of propagation of wave.
D. The electric field, magnetic field and direction of propagation of wave must be perpendicular to each other.
E. The ratio of amplitude of magnetic field to the amplitude of electric field is equal to speed of light.

Choose the most appropriate answer from the options given below:
(A) D only
(B) B and D only
(C) B, C and E only
(D) A, B and E only

SOLUTION

7. Match List – I with List – II

List – I	List - II
(a) UV rays	(i) Diagnostic tool in medicine
(b) X-rays	(ii) Water purification
(c) Microwave	(iii) Communication, Radar
(d) Infrared wave	(iv) Improving visibility in foggy days

Choose the correct answer from the options given below :

(A) (a)–(iii), (b)-(ii), (c)-(i), (d)-(iv)
(B) (a)–(ii), (b)-(i), (c)-(iii), (d)-(iv)
(C) (a)–(ii), (b)-(iv), (c)-(iii), (d)-(i)
(D) (a)–(iii), (b)-(i), (c)-(ii), (d)-(iv)

8. Nearly 10% of the power of a 110 W light bulb is converted to visible radiation. The change in average intensities of visible radiation, at a distance of 1 m from the bulb to a distance of 5 m is $a \times 10^{-2}$ W/m^2. The value of 'a' will be

SOLUTION

ANSWER KEY

1. B
2. A
3. C
4. D
5. C
6. B
7. B
8. 84

1.

	List I		List II
A.	Microwaves	I.	Radio active decay of the nucleus
B.	Gamma rays	II.	Rapid acceleration and deceleration of electron in aerials
C.	Radio waves	III.	Inner shell electrons
D.	X-rays	IV.	Klystron valve

Choose the **correct** answer from the options given below:

(1) A-I, B-II, C-III, D-IV
(2) A-IV, B-I, C-II, D-III
(3) A-I, B-III, C-IV, D-II
(4) A-IV, B-III, C-II, D-I

2. The ratio of average electric energy density and total average energy density of electromagnetic wave is:

(1) 2 (2) 1
(3) 3 (4) $\frac{1}{2}$

3. If $\vec{E}$ and $\vec{K}$ represent electric field and propagation vectors of the EM waves in vacuum, then magnetic field vector is given by : (ω - angular frequency) :

(1) $\frac{1}{\omega}(\vec{K}\times\vec{E})$ (2) $\omega(\vec{E}\times\vec{K})$
(3) $\omega(\vec{K}\times\vec{E})$ (4) $\vec{K}\times\vec{E}$

4. The electric field and magnetic field components of an electromagnetic wave going through vacuum is described by

$E_x = E_0 \sin(kz - \omega t)$

$B_y = B_0 \sin(kz - \omega t)$

Then the correct relation between E_0 and B_0 is given by

(1) $kE_0 = \omega B_0$ (2) $E_0B_0 = \omega k$
(3) $\omega E_0 = kB_0$ (4) $E_0 = kB_0$

5. All electromagnetic wave is transporting energy in the negative z direction. At a certain point and certain time the direction of electric field of the wave is along positive y direction. What will be the direction of the magnetic field of the wave at that point and instant?

(1) Positive direction of x
(2) Positive direction of z
(3) Negative direction of x
(4) Negative direction of y

6.

	List-I		List-II
A.	Gauss's Law in Electrostatics	I.	$\oint \vec{E}.d\vec{l} = -\frac{d\phi_B}{dt}$
B.	Faraday's Law	II.	$\oint \vec{B}.d\vec{A} = 0$
C.	Gauss's Law in Magnetism	III.	$\oint \vec{B}.d\vec{l} = \mu_0 i_C + \mu_0 \in_0 \frac{d\phi_E}{dt}$
D.	Ampere-Maxwell Law	IV.	$\oint \vec{E}.d\vec{s} = \frac{q}{\in_0}$

Choose the correct answer from the options given below :

(1) A-IV, B-I, C-II, D-III
(2) A-I, B-II, C-III, D-IV
(3) A-III, B-IV, C-I, D-II
(4) A-II, B-III, C-IV, D-I

SOLUTION

7. Which of the following are true?

A. Speed of light in vacuum is dependent on the direction of propagation.

B. Speed of light in a medium in independent of the wavelength of light.

C. The speed of light is independent of the motion of the source.

D. The speed of light in a medium is independent of intensity.

Choose the correct answer from the option given below :

(1) A and C only (2) B and D only

(3) B and C only (4) C and D only

8. Given below are two statements:

Statement I : Electromagnetic waves are not deflected by electric and magnetic field.

Statement II : The amplitude of electric field and the magnetic field in electromagnetic waves are related to each other as $E_0 = \sqrt{\frac{\mu_0}{\varepsilon_0}} B_0$.

In the light of the above statements, choose the correct answer from the options given below:

(1) Statement I is true but statement II is false

(2) Both Statement I and Statement II are true

(3) Statement I is false but statement II is true

(4) Both Statement I and Statement II are false

9. A point source of 100 W emits light with 5% efficiency. At a distance of 5 m from the source, the intensity produced by the electric field component is :

(1) $\frac{1}{2\pi}\frac{W}{m^2}$ (2) $\frac{1}{40\pi}\frac{W}{m^2}$

(3) $\frac{1}{10\pi}\frac{W}{m^2}$ (4) $\frac{1}{20\pi}\frac{W}{m^2}$

10. If a source of electromagnetic radiation having power 15 kW produces 10^{16} photons per second, the radiation belongs to a part of spectrum is.

(Take Planck constant $h = 6 \times 10^{-34}$ Js)

(1) Micro waves (2) Ultraviolet rays

(3) Gamma rays (4) Radio waves

11. In a medium the speed of light wave decreases to 0.2 times to its speed in free space The ratio of relative permittivity to the refractive index of the medium is x : 1. The value of x is _____.

(Given speed of light in free space = 3×10^8 m s^{-1} and for the given medium $\mu_r = 1$)

12 Match List-I with List-II.

	List-I		List-II
A.	Microwaves	I	Physiotherapy
B	UV rays	II	Treatment of cancer
C	Infra-red rays	III	Lasik eye surgery
D	X-rays	IV	Aircraft navigation

Choose the correct answer from the option given below:

(1) A-II, B-IV, C-III, D-I

(2) A-IV, B-I, C-II, D-III

(3) A-IV, B-III, C-I, D-II

(4) A-III, B-II, C-I, D-IV

SOLUTION

ANSWER KEY

1. 2
2. 4
3. 1
4. 1
5. 1
6. 1
7. 4
8. 1
9. 2
10. 3
11. 5
12. 3

1. For the plane electromagnetic wave given by $E = E_0 \sin(\omega t - kx)$ and $B = B_0 \sin(\omega t - kx)$, the ratio of average electric energy density to average magnetic energy density is
(1) 1 (2) 1/2
(3) 2 (4) 4

2. The energy density associated with electric field $\vec{E}$ and magnetic field $\vec{B}$ of an electromagnetic wave in free space is given by (ϵ_0 – permittivity of free space, μ_0 - permeability of free space)
(1) $U_E = \frac{E^2}{2\epsilon_0}, U_B = \frac{B^2}{2\mu_0}$
(2) $U_E = \frac{E^2}{2\epsilon_0}, U_B = \frac{\mu_0 B^2}{2}$
(3) $U_E = \frac{\epsilon_0 E^2}{2}, U_B = \frac{\mu_0 B^2}{2}$
(4) $U_E = \frac{\epsilon_0 E^2}{2}, U_B = \frac{B^2}{2\mu_0}$

3. The waves emitted when a metal target is bombarded with high energy electrons are
(1) Microwaves (2) X-rays
(3) Infrared rays (4) Radio Waves

4. The energy of an electromagnetic wave contained in a small volume oscillates with
(1) zero frequency
(2) half the frequency of the wave
(3) double the frequency of the wave
(4) the frequency of the wave

5. The amplitude of magnetic field in an electromagnetic wave propagating along y-axis is 6.0×10^{-7} T. The maximum value of electric field in the electromagnetic wave is:
(1) 5×10^{14} Vm^{-1}
(2) 180 Vm^{-1}
(3) 2×10^{15} Vm^{-1}
(4) 6.0×10^{-7} Vm^{-1}

6. The electric field in an electromagnetic wave is given as $\vec{E} = 20 \sin\omega\left(t - \frac{x}{c}\right)\vec{j}NC^{-1}$

Where ω and c are angular frequency and velocity of electromagnetic wave respectively. The energy contained in a volume of $5 \times 10^{-4} m^3$ will be
(Given $\varepsilon_0 = 8.85 \times 10^{-12} C^2/Nm^2$)
(1) 28.5×10^{-13} J (2) 17.7×10^{-13} J
(3) 8.85×10^{-13} J (4) 88.5×10^{-13} J

7. A plane electromagnetic wave of frequency 20 MHz propagates in free space along x-direction. At a particular space and time, $\vec{E} = 6.6\hat{j}$ V/m. What is $\vec{B}$ at this point ?
(1) $-2.2 \times 10^{-8}\hat{i}$ T (2) $2.2 \times 10^{-8}\hat{k}$ T
(3) $-2.2 \times 10^{-8}\hat{k}$ T (4) $2.2 \times 10^{-8}\hat{i}$ T

8. Given below are two statement : one is labelled as Assertion A and the other is labelled as Reason R.
Assertion A : EM waves used for optical communication have longer wavelengths than that of microwave, employed in Radar technology.
Reason R : Infrared EM waves are more energetic than microwaves, (used in Radar)
In the light of given statements, choose the correct answer from the options given below:
(1) A is false but R is true
(2) A is true but R is false
(3) Both A and R true but R is NOT the correct explanation of A
(4) Both A and R true and r is the correct explanation of A

SOLUTION

9. Which of the following Maxwell's equations is valid for time varying conditions but not valid for static conditions :

(1) $\oint \vec{B}.\vec{dl} = \mu_0 I$ (2) $\oint \vec{E}.\vec{dl} = 0$

(3) $\oint \vec{E}.\vec{dl} = -\frac{\partial \phi_B}{\partial t}$ (4) $\oint \vec{D}.\vec{dA} = Q$

10. In an electromagnetic wave, at an instant and at a particular position, the electric field is along the negative z-axis and magnetic field is along the positive x-axis. Then the direction of propagation of electromagnetic wave is :

(1) at 45° angle from positive y-axis

(2) negative y-axis

(3) positive z-axis

(4) positive y-axis

11.

List I	**List II**
(A) Microwave	(I) 400 nm to 1 nm
(B) Ultraviolet	(II) 1 nm to 10^{-3} nm
(C) X-Ray	(III) 1 mn to 700 nm
(D) Infra-red	(IV) 0.1 m to 1mm

Choose the correct answer from the options given below :

(1) (A)-(I), (B)-(IV), (C)-(II), (D)-(III)

(2) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

(3) (A)-(IV), (B)-(II), (C)-(I), (D)-(III)

(4) (A)-(IV), (B)-(I), (C)-(III), (D)-(II)

SOLUTION

EM Waves

1. 1
2. 4
3. 2
4. 3
5. 2
6. 3
7. 2
8. 1
9. 3
10. 2
11. 2

1. A parallel plate capacitor has a capacitance C = 200 pF. It is connected to 230 V ac supply with an angular frequency 300 rad/s. The rms value of conduction current in the circuit and displacement current in the capacitor respectively are :

(1) 1.38 μA and 1.38 μA

(2) 14.3 μA and 143 μA

(3) 13.8 μA and 138 μA

(4) 13.8 μA and 13.8 μA

2. If frequency of electromagnetic wave is 60 MHz and it travels in air along z direction then the corresponding electric and magnetic field vectors will be mutually perpendicular to each other and the wavelength of the wave (in m) is :

(1) 2.5 (2) 10

(3) 5 (4) 2

3. A plane electromagnetic wave propagating in x-direction is described by

$E_y = (200\ \text{Vm}^{-1}) \sin[1.5 \times 10^7 t - 0.05\ x]$;

The intensity of the wave is :

(Use $\epsilon_0 = 8.85 \times 10^{-12}\ C^2N^{-1}m^{-2}$)

(1) 35.4 Wm^{-2}

(2) 53.1 Wm^{-2}

(3) 26.6 Wm^{-2}

(4) 106.2 Wm^{-2}

4.

	List I		List II
A.	$\oint \vec{B}.\vec{dl} = \mu_0 i_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$	I.	Gauss' law for electricity
B.	$\oint \vec{E}.\vec{dl} = \frac{d\phi_B}{dt}$	II.	Gauss' law for magnetism
C.	$\oint \vec{E}.\overrightarrow{dA} = \frac{Q}{\varepsilon_0}$	III.	Faraday law
D.	$\oint \vec{B}.\overrightarrow{dA} = 0$	IV.	Ampere – Maxwell law

Chose the correct answer from the options given below

(1) A-IV, B-I, C-III, D-II (3) A-IV, B-III, C-I, D-II

(2) A-II, B-III, C-I, D-IV (4) A-I, B-II, C-III, D-IV

5. A plane electromagnetic wave of frequency 35 MHz travels in free space along the X-direction. At a particular point (in space and time) $\vec{E} = 9.6\hat{j}\,V/m$. The value of magnetic field at this point is :

(1) $3.2\times10^{-8}\hat{k}T$ (2) $3.2\times10^{-8}\hat{i}T$

(3) $9.6\hat{j}T$ (4) $9.6\times10^{-8}\hat{k}T$

6. The electric field of an electromagnetic wave in free space is represented as $\vec{E} = E_0 \cos(\omega t - kz)\hat{i}$. The corresponding magnetic induction vector will be :

(1) $\vec{B} = E_0 C \cos(\omega t - kz)\hat{j}$

(2) $\vec{B} = \frac{E_0}{C}\cos(\omega t - kz)\hat{j}$

(3) $\vec{B} = E_0 C \cos(\omega t + kz)\hat{j}$

(4) $\vec{B} = \frac{E_0}{C}\cos(\omega t + kz)\hat{j}$

7. Match List I with List II

	List-I		List-II
A.	Gauss's law of magnetostatics	I.	$\oint \vec{E}\cdot\vec{da} = \frac{1}{\varepsilon_0}\int \rho dV$
B.	Faraday's law of electro magnetic induction	II.	$\oint \vec{B}\cdot\vec{da} = -0$
C.	Ampere's law	III.	$\oint \vec{E}\cdot\vec{dl} = \frac{-d}{dt}\int \vec{B}\cdot\vec{da}$
D.	Gauss's law of electrostatics	IV.	$\oint \vec{B}\cdot\vec{dl} = -\mu_0 I$

Choose the correct answer from the options given below:

(1) A-I, B-III, C-IV, D-II

(2) A-III, B-IV, C-I, D-II

(3) A-IV, B-II, C-III, D-I

(4) A-II, B-III, C-IV, D-I

SOLUTION - CLICK

8. In a plane EM wave, the electric field oscillates sinusoidally at a frequency of 5×10^{10} Hz and an amplitude of 50 Vm^{-1}. The total average energy density of the electromagnetic field of the wave is :
[Use $\varepsilon_0 = 8.85 \times 10^{-12} C^2 / Nm^2$]
(1) $1.106 \times 10^{-8} Jm^{-3}$
(2) $4.425 \times 10^{-8} Jm^{-3}$
(3) $2.212 \times 10^{-8} Jm^{-3}$
(4) $2.212 \times 10^{-10} Jm^{-3}$

9. **Statement I:** Electromagnetic waves carry energy as they travel through space and this energy is equally shared by the electric and magnetic fields.
Statement II: When electromagnetic waves strike a surface, a pressure is exerted on the surface.
In the light of the above statements, choose the most appropriate answer from the options given below:
(1) Statement I is incorrect but Statement II is correct
(2) Both Statement I and Statement II are correct.
(3) Both Statement I and Statement II are incorrect.
(4) Statement I is correct but Statement II is incorrect.

SOLUTION - CLICK

Answer Key

1. 4
2. 3
3. 2
4. 3
5. 1
6. 2
7. 4
8. 1
9. 2

SOLUTION - CLICK

1. The electric field in an electromagnetic wave is given by $\vec{E} = \hat{i}40\cos\omega\left(t - \frac{z}{c}\right)NC^{-1}$. The magnetic field induction of this wave is (in SI unit):

(1) $\vec{B} = \hat{i}\frac{40}{c}\cos\omega\left(t - \frac{z}{c}\right)$

(2) $\vec{B} = \hat{j}40\cos\omega\left(t - \frac{z}{c}\right)$

(3) $\vec{B} = \hat{k}\frac{40}{c}\cos\omega\left(t - \frac{z}{c}\right)$

(4) $\vec{B} = \hat{j}\frac{40}{c}\cos\omega\left(t - \frac{z}{c}\right)$

2. Arrange the following in the ascending order of wavelength :

(A) Gamma rays (λ_1) (B) x-ray (λ_2)

(C) Infrared waves (λ_3) (D) Microwaves (λ_4)

Choose the most appropriate answer from the options given below :

(1) $\lambda_4 < \lambda_3 < \lambda_1 < \lambda_2$ (2) $\lambda_4 < \lambda_3 < \lambda_2 < \lambda_1$

(3) $\lambda_1 < \lambda_2 < \lambda_3 < \lambda_4$ (4) $\lambda_2 < \lambda_1 < \lambda_4 < \lambda_3$

3. An alternating voltage of amplitude 40 V and frequency 4 kHz is applied directly across the capacitor of 12 μF. The maximum displacement current between the plates of the capacitor is nearly:

(1) 13 A (2) 8 A

(3) 10 A (4) 12 A

4.

	List-I EM-Wave		List-II Wavelength Range
(A)	Infra-red	(I)	$< 10^{-3}$ nm
(B)	Ultraviolet	(II)	400 nm to 1 nm
(C)	X-rays	(III)	1 mm to 700 nm
(D)	Gamma rays	(IV)	1 nm to 10^{-3} nm

Choose the correct answer from the options given below :

(1) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)

(2) (A)-(III), (B)-(II), (C)-(IV), (D)-(I)

(3) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(4) (A)-(I), (B)-(III), (C)-(II), (D)-(IV)

5. Electromagnetic waves travel in a medium with speed of 1.5×10^8 ms^{-1}. The relative permeability of the medium is 2.0. The relative permittivity will be :

(1) 5 (2) 1

(3) 4 (4) 2

6. In the given electromagnetic wave $E_y = 600 \sin(\omega t - kx)$ Vm^{-1}, intensity of the associated light beam is (in W/m^2); (Given $\epsilon_0 = 9\times10^{-12}C^2N^{-1}m^{-2}$)

(1) 486 (2) 243

(3) 729 (4) 972

7. A plane EM wave is propagating along x direction. It has a wavelength of 4 mm. If electric field is in y-direction with the maximum magnitude of 60 Vm^{-1}, the equation for magnetic field is:

(1) $B_z = 60\sin\left[\frac{\pi}{2}\left(x - 3\times10^8 t\right)\right]\hat{k}T$

(2) $B_z = 2\times10^{-7}\sin\left[\frac{\pi}{2}\times10^3\left(x - 3\times10^8 t\right)\right]\hat{k}T$

(3) $B_x = 60\sin\left[\frac{\pi}{2}\left(x - 3\times10^8 t\right)\right]\hat{i}T$

(4) $B_z = 2\times10^{-7}\sin\left[\frac{\pi}{2}\left(x - 3\times10^8 t\right)\right]\hat{k}T$

8. **Statement (I) :** When currents vary with time, Newton's third law is valid only if momentum carried by the electromagnetic field is taken into account.

Statement (II) : Ampere's circuital law does not depend on Biot-Savart's law.

In the light of the above statements, choose the **correct** answer from the options given below:

(1) Both **Statement I** and **Statement II** are false.

(2) **Statement I** is true but **Statement II** is false.

(3) **Statement I** is false but **Statement II** is true.

(4) Both **Statement I** and **Statement II** are true.

SOLUTION - CLICK

9. The magnetic field in a plane electromagnetic wave is $B_y = (3.5 \times 10^{-7}) \sin (1.5 \times 10^3 x + 0.5 \times 10^{11} t)$T. The corresponding electric field will be

(1) $E_y = 1.17 \sin (1.5 \times 10^3 x + 0.5 \times 10^{11} t) Vm^{-1}$

(2) $E_z = 105 \sin (1.5 \times 10^3 x + 0.5 \times 10^{11} t) Vm^{-1}$

(3) $E_z = 1.17 \sin (1.5 \times 10^3 x + 0.5 \times 10^{11} t) Vm^{-1}$

(4) $E_y = 10.5 \sin (1.5 \times 10^3 x + 0.5 \times 10^{11} t) Vm^{-1}$

SOLUTION - CLICK

Answer Key

1. 4
2. 3
3. 4
4. 2
5. 4
6. 1
7. 2
8. 2
9. NTA gave option 2 (But none option is matching)

SOLUTION - CLICK

1. The energy required to ionise a hydrogen like ion in its ground state is 9 Rydbergs. What is the wavelength of the radiation emitted when the electron in this ion jumps from the second excited state to the ground state?
(a) 8.6 nm (b) 24.2 nm
(c) 11.4 nm (d) 35.8 nm

2. The time period of revolution of electron in its ground state orbit in a hydrogen atom is 1.6×10^{-16} s. The frequency of revolution of the electron in its first excited state (in s^{-1}) is
(a) 5.6×10^{12} (b) 1.6×10^{14}
(c) 7.8×10^{14} (d) 6.2×10^{15}

3. In a hydrogen atom the electron makes a transition from $(n+1)^{th}$ level to the n^{th} level. If $n>>1$, the frequency of radiation emitted is proportional to
(a) $\frac{1}{n^4}$ (b) $\frac{1}{n^3}$
(c) $\frac{1}{n^2}$ (d) $\frac{1}{n}$

4. The first member of the Balmer series of hydrogen atom has a wavelength of 6561 Å. The wavelength of the second member of the Balmer series (in nm) is

5. A particle of mass 200 MeV/c^2 collides with a hydrogen atom at rest. Soon after the collision the particle comes to rest, and the atom recoils and goes to its first excited state. The initial kinetic energy of the particle (in eV) is $N/4$. The value of N is (Given the mass of the hydrogen atom to be 1 GeV/c^2)

6. In the line spectra of hydrogen atom, difference between the largest and the shortest wavelengths of the Lyman series is 304 Å. The corresponding difference for the Paschen series in Å is

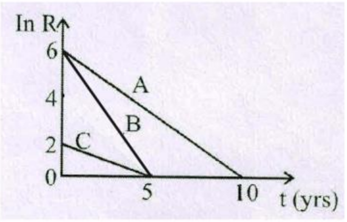
7. The radius of R of a nucleus of mass number A can be estimated by the formula $R = (1.3\times10^{-15})A^{1/3}$ m. It follows that the mass density of a nucleus is of the order of $(M_{\text{prot.}} \cong M_{\text{neut.}} \simeq 1.67\times10^{-27}\text{ kg})$
(a) 10^{24} kg m^{-3} (b) 10^{3} kg m^{-3}
(c) 10^{17} kg m^{-3} (d) 10^{10} kg m^{-3}

8. In a radioactive material, fraction of active material remaining after time t is 9/16. The fraction that was remaining after $t/2$ is
(a) $\frac{3}{4}$ (b) $\frac{7}{8}$
(c) $\frac{3}{5}$ (d) $\frac{4}{5}$

9. The activity of a radioactive sample falls from 700 s^{-1} to 500 s^{-1} in 30 minutes. Its half life is close to
(a) 72 min (b) 62 min
(c) 66 min (d) 52 min

10. A radioactive nucleus decays by two different processes. The half life for the first process is 10s and that for the second is 100s. The effective half life of the nucleus is close to
(a) 9 sec (b) 55 sec
(c) 6 sec (d) 12 sec

11. Activities of three radioactive substances A, B and C are represented by the curves A, B and C, in the figure. Then their half-lives $T_{\frac{1}{2}}(A) : T_{\frac{1}{2}}(B) : T_{\frac{1}{2}}(C)$ are in the ratio



(a) 3 : 2 : 1 (b) 4 : 3 : 1
(c) 2 : 1 : 3 (d) 2 : 1 : 1

12. Find the bindng energy per nucleon for $^{120}_{50}Sn$. Mass of proton $m_p = 1.00783$ U, mass of neutron $m_n = 1.00867$ U and mass of tin nucleus $m_{Sn} = 119.902199$ U. (take 1U = 931 MeV)
(a) 8.5 MeV (b) 7.5 MeV
(c) 8.0 MeV (d) 9.0 MeV

13. In a reactor, 2 kg of $_{92}U^{235}$ fuel is fully used up in 30 days. The energy released per fission is 200 MeV. Given that the Avogadro number, N = 6.023 × 10^{26} per kilo mole and 1 eV = 1.6 × 10^{-19} J. The power output of the reactor is close to
(a) 125 MW (b) 35 MW
(c) 60 MW (d) 54 MW

14. You are given that Mass of $^7_3Li = 7.0160$ u,
Mass of $^4_2He = 4.0026$ u
and Mass of $^1_1H = 1.0079$ u.
When 20 g of ^7_3Li is converted into ^4_2He by proton capture, the energy liberated, (in kWh), is [Mass of nucleon = 1 GeV/c^2]
(a) 8 × 10^6 (b) 1.33 × 10^6
(c) 6.82 × 10^5 (d) 4.5 × 10^5

15. Given the masses of various atomic particles $m_p = 1.0072$u, $m_n = 1.0087$u, $m_e = 0.000548$u, $m_{\bar{\nu}} = 0$, $m_d = 2.0141$u, where $p \equiv$ proton, $n \equiv$ neutron, $e \equiv$ electron, $\bar{\nu} \equiv$ antineutrino and $d \equiv$ deuteron. Which of the following process is allowed by momentum and energy conservation?
(a) $n + p \to d + \gamma$
(b) $e^+ + e^- \to \gamma$
(c) $n + n \to$ deuterium atom (electron bound to the nucleus)
(d) $p \to n + e^+ + \bar{\nu}$

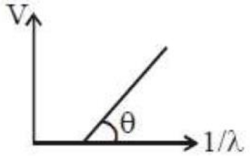
16. When the wavelength of radiation falling on a metal is changed from 500 nm to 200 nm, the maximum kinetic energy of the photoelectrons becomes three times larger. The work function of the metal is close to
(a) 0.61 eV (b) 0.52 eV
(c) 0.81 eV (d) 1.02 eV

SOLUTION

17. Two sources of light emit X-rays of wavelength 1 nm and visible light of wavelength 500 nm, respectively. Both the sources emit light of the same power 200 W. The ratio of the number density of photons of X-rays to the number densitty of photons of the visible light of the given wavelengths is

(a) $\frac{1}{500}$ (b) $\frac{1}{250}$
(c) 250 (d) 500

18. In a photoelectric effect experiment, the graph of stopping potential V versus reciprocal of wavelength obtained is shown in the figure. As the intensity of incident radiation is increased



(a) Slope of the straight line get more steep
(b) Straight line shifts to left
(c) Graph does not change
(d) Straight line shifts to right

19. Radiation, with wavelength 6561 Å falls on a metal surface to produce photoelectrons. The electrons are made to enter a uniform magnetic field of 3×10^{-4} T. If the radius of the largest circular path followed by the electrons is 10 mm, the work function of the metal is close to
(a) 0.8 eV (b) 1.1 eV
(c) 1.8 eV (d) 1.6 eV

20. A particle is moving 5 times as fast as an electron. The ratio of the de-Broglie wavelength of the particle to that of the electron is 1.878×10^{-4}. The mass of the particle is close to
(a) 4.8×10^{-27} kg (b) 1.2×10^{-28} kg
(c) 9.1×10^{-31} kg (d) 9.7×10^{-28} kg

21. An electron, a doubly ionized helium ion (He^{++}) and a proton are having the same kinetic energy. The relation between their respective de-Broglie wavelengths $\lambda_e, \lambda_{He^{++}}$ and λ_P is
(a) $\lambda_e < \lambda_P < \lambda_{He^{++}}$ (b) $\lambda_e < \lambda_{He^{++}} = \lambda_P$
(c) $\lambda_e > \lambda_{He^{++}} > \lambda_P$ (d) $\lambda_e > \lambda_P > \lambda_{He^{++}}$

22. An electron (of mass m) and a photon have the same energy E in the range of a few eV. The ratio of the de-Broglie wavelength associated with the electron and the wavelength of the photon is (c = speed of light in vacuum)
(a) $\left(\frac{E}{2m}\right)^{1/2}$ (b) $\frac{1}{c}\left(\frac{2E}{m}\right)^{1/2}$
(c) $c(2mE)^{1/2}$ (d) $\frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$

23. A particle moving with kinetic energy E has de Broglie wavelength λ. If energy ΔE is added to its energy, the wavelength becomes $\lambda/2$. Value of ΔE is
(a) $2E$ (b) $4E$
(c) $3E$ (d) E

24. When photon of energy 4.0 eV strikes the surface of a metal A, the ejected photoelectrons have maximum kinetic energy T_A eV and and de-Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photon of energy 4.50 eV is $T_B = (T_A - 1.5)$ eV. If the de-Broglie wavelength of these photoelectrons $\lambda_B = 2\lambda_A$, then the work function of metal B is
(a) 1.5 eV (b) 4 eV
(c) 3 eV (d) 2 eV

25. An electron of mass m and magnitude of charge $|e|$ initially at rest gets accelerated by a constant electric field E. The rate of change of de-Broglie wavelength of this electron at time t ignoring relativistic effects is
(a) $\frac{-h}{|e|Et^2}$ (b) $\frac{|e|Et}{h}$
(c) $-\frac{h}{|e|Et}$ (d) $-\frac{h}{|e|E\sqrt{t}}$

26. Assuming the nitrogen molecule is moving with r.m.s. velocity at 400K, the de-Broglie wavelength of nitrogen molecule is close to
(Given : nitrogen molecule weight 4.64×10^{-26} kg, Boltzman constant 1.38×10^{-23} J/K, Planck constant: 6.63×10^{-23} J.s)
(a) 0.34 Å (b) 0.24 Å
(c) 0.20 Å (d) 0.44 Å

27. Particle A of mass $m_A = m/2$ moving along the x-axis with velocity v_0 collides elastically with another particle B at rest having mass $m_B = m/3$. If both particles move along the x-axis after the collision, the change $\Delta\lambda$ in de-Broglie wavelength of particle A, in terms of its de-Broglie wavelength (λ_0) before collision is
(a) $\Delta\lambda = 4\lambda_0$ (b) $\Delta\lambda = 2\lambda_0$
(c) $\Delta\lambda = \frac{5}{2}\lambda_0$ (d) $\Delta\lambda = \frac{3}{2}\lambda_0$

28. An electron (mass m) with initial velocity $\vec{v} = v_0\hat{i} + v_0\hat{j}$ is in an electric field $\vec{E} = -E_0\hat{k}$. If λ_0 is initial de-Broglie wavelength of electron, its de-Broglie wavelength at time t is given by
(a) $\frac{\lambda_0}{\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}}$ (b) $\frac{\lambda_0}{\sqrt{2+\frac{e^2E_0^2t^2}{m^2v_0^2}}}$
(c) $\frac{\lambda_0}{\sqrt{1+\frac{e^2E_0^2t^2}{2m^2v_0^2}}}$ (d) $\frac{\lambda_0\sqrt{2}}{\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}}$

29. The surface of a metal is illuminated alternately with photons of energies $E_1 = 4$eV and $E_2 = 2.5$ eV respectively. The ratio of maximum speeds of the photoelectrons emitted in the two cases is 2. The work function of the metal in (eV) is __ .

30. When radiation of wavelength λ is used to illuminate a metallic surface, the stopping potential is V. When the same surface is illuminated with radiation of wavelength 3λ, the stopping potential is $V/4$. If the threshold wavelength for the metallic surface is $n\lambda$ then value of n will be

SOLUTION

31. A beam of electromagnetic radiation of intensity 6.4×10^{-5} W/cm^2 is comprised of wavelength, $\lambda = 310$ nm. It falls normally on a metal (work function $\phi_0 = 2$ eV) of surface area of 1 cm^2. If one in 10^3 photons ejects an electron, total number of electrons ejected in 1 s is 10^x. (hc = 1240 eVnm, $1\text{eV} = 1.6 \times 10^{-19}$ J), then x is _____ .

32. A beam of electrons of energy E scatters from a target having atomic spacing of 1Å. The first maximum intensity occurs at $\theta = 60°$. Then E (in eV) is ____
(Planck constant $h = 6.64 \times 10^{-34}$ Js, $1\text{eV} = 1.6 \times 10^{-19}$ J, electron mass $m = 9.1 \times 10^{-31}$ kg)

SOLUTION

ANSWER KEY

1. c
2. c
3. b
4. 486
5. 51
6. 10553.14
7. c
8. a
9. b
10. a
11. c
12. a
13. c
14. b
15. a
16. a
17. a
18. c
19. b
20. d
21. d
22. d
23. c
24. b
25. a
26. b
27. a
28. c
29. 2
30. 9
31. 11
32. 50.47

Feb Attempt

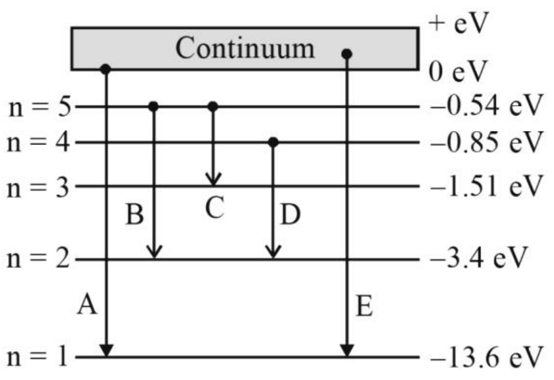
1. The de Broglie wavelength of a proton and α-particle are equal. The ratio of their velocities is :
(1) 4 : 3 (2) 4 : 1 (3) 4 : 2 (4) 1 : 4

2. An X-ray tube is operated at 1.24 million volt. The shortest wavelength of the produced photon will be :
(1) 10^{-3} nm (2) 10^{-1} nm
(3) 10^{-2} nm (4) 10^{-4} nm

3. According to Bohr atom model, in which of the following transitions will the frequency be maximum ?
(1) n = 4 to n = 3 (2) n = 2 to n = 1
(3) n = 5 to n = 4 (4) n = 3 to n = 2

4. Given below are two statements :
Statement-I : Two photons having equal linear momenta have equal wavelengths.
Statement-II : If the wavelength of photon is decreased, then the momentum and energy of a photon will also decrease.
In the light of the above statements, choose the correct answer from the options given below.
(1) Both Statement I and Statement II are true
(2) Statement I is false but Statement II is true
(3) Both Statement I and Statement II are false
(4) Statement I is true but Statement II is false

5. In the given figure, the energy levels of hydrogen atom have been shown along with some transitions marked A, B, C, D and E. The transitions A, B and C respectively represent :



(1) The ionization potential of hydrogen, second member of Balmer series and third member of Paschen series.
(2) The first member of the Lyman series, third member of Balmer series and second member of Paschen series.
(3) The series limit of Lyman series, third member of Balmer series and second member of Paschen series.
(4) The series limit of Lyman series, second member of Balmer series and second member of Paschen series.

6. The wavelength of the photon emitted by a hydrogen atom when an electron makes a transition from n = 2 to n = 1 state is :
(1) 194.8 nm (2) 913.3 nm
(3) 490.7 nm (4) 121.8 nm

7. An electron of mass m_e and a proton of mass $m_p = 1836\, m_e$ are moving with the same speed. The ratio of their de Broglie wavelength $\frac{\lambda_{electron}}{\lambda_{proton}}$ will be :
(1) 1836 (2) 1
(3) 918 (4) $\frac{1}{1836}$

8. The stopping potential for electrons emitted from a photosensitive surface illuminated by light of wavelength 491 nm is 0.710 V. When the incident wavelength is changed to a new value, the stopping potential is 1.43 V. The new wavelength is :
(1) 329 nm (2) 309 nm
(3) 382 nm (4) 400 nm

9. The wavelength of an X-ray beam is 10Å. The mass of a fictitious particle having the same energy as that of the X-ray photons is $\frac{x}{3}$h kg. The value of x is_________.
(h = Planck's constant)

SOLUTION

10. An α particle and a proton are accelerated from rest by a potential difference of 200 V. After this, their de Broglie wavelengths are λ_α and λ_p respectively. The ratio $\frac{\lambda_p}{\lambda_\alpha}$ is :

(1) 3.8 (2) 8 (3) 7.8 (4) 2.8

11. Two radioactive substances X and Y originally have N_1 and N_2 nuclei respectively. Half life of X is half of the half life of Y. After three half lives of Y, number of nuclei of both are equal. The ratio $\frac{N_1}{N_2}$ will be equal to :

(1) $\frac{1}{8}$ (2) $\frac{3}{1}$

(3) $\frac{8}{1}$ (4) $\frac{1}{3}$

12. The recoil speed of a hydrogen atom after it emits a photon in going from n = 5 state to n = 1 state will be :-

(1) 4.17 m/s (2) 2.19 m/s

(3) 3.25 m/s (4) 4.34 m/s

13. A radioactive sample is undergoing α decay. At any time t_1, its activity is A and another time t_2, the activity is $\frac{A}{5}$. What is the average life time for the sample ?

(1) $\frac{\ell n5}{t_2 - t_1}$ (3) $\frac{t_2 - t_1}{\ell n5}$

(2) $\frac{t_1 - t_2}{\ell n5}$ (4) $\frac{\ell n(t_2 + t_1)}{2}$

14. Two stream of photons, possessing energies equal to twice and ten times the work function of metal are incident on the metal surface successively. The value of ratio of maximum velocities of the photoelectrons emitted in the two respective cases is x : y. The value of x is ....

SOLUTION

15. If λ_1 and λ_2 are the wavelengths of the third member of Lyman and first member of the Paschen series respectively, then the value of $\lambda_1 : \lambda_2$ is :

(1) 1 : 9 (2) 7 : 108

(3) 7 : 135 (4) 1 : 3

16. **Assertion A :** An electron microscope can achieve better resolving power than an optical microscope.

Reason R : The de Broglie's wavelength of the electrons emitted from an electron gun is much less than wavelength of visible light.

In the light of the above statements, choose the correct answer from the options given below:

(1) A is true but R is false.

(2) Both A and R are true and R is the correct explanation of A.

(3) Both A and R are true but R is NOT the correct explanation of A.

(4) A is false but R is true.

March Attempt

1. The stopping potential in the context of photoelectric effect depends on the following property of incident electromagnetic radiation :

(1) Phase (2) Intensity

(3) Amplitude (4) Frequency

2. The first three spectral lines of H-atom in the Balmer series are given λ_1, λ_2, λ_3 considering the Bohr atomic model, the wave lengths of first and third spectral lines $\left(\frac{\lambda_1}{\lambda_3}\right)$ are related by a factor of approximately 'x' $\times 10^{-1}$. The value of x, to the nearest integer, is ________.

3. The de-Broglie wavelength associated with an electron and a proton were calculated by accelerating them through same potential of 100 V. What should nearly be the ratio of their wavelengths ? ($m_P = 1.00727$ u, $m_e = 0.00055$u)

(1) 1860 : 1 (2) $(1860)^2$: 1

(3) 41.4 : 1 (4) 43 : 1

4. The half-life of Au^{198} is 2.7 days. The activity of 1.50 mg of Au^{198} if its atomic weight is 198 g mol^{-1} is, ($N_A = 6 \times 10^{23}$/mol)
(1) 240 Ci (2) 357 Ci
(3) 535 Ci (4) 252 Ci

5. Calculate the time interval between 33% decay and 67% decay if half-life of a substance is 20 minutes.
(1) 60 minutes (2) 20 minutes
(3) 40 minutes (4) 13 minutes

6. If an electron is moving in the n^{th} orbit of the hydrogen atom, then its velocity (v_n) for the n^{th} orbit is given as :
(1) $v_n \propto n$ (2) $v_n \propto \frac{1}{n}$
(3) $v_n \propto n^2$ (4) $v_n \propto \frac{1}{n^2}$

7. An electron of mass m and a photon have same energy E. The ratio of wavelength of electron to that of photon is : (c being the velocity of light)
(1) $\frac{1}{c}\left(\frac{2m}{E}\right)^{1/2}$ (2) $\frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$
(3) $\left(\frac{E}{2m}\right)^{1/2}$ (4) $c\,(2mE)^{1/2}$

8. Which level of the single ionized carbon has the same energy as the ground state energy of hydrogen atom?
(1) 1 (2) 6
(3) 4 (4) 8

9. The atomic hydrogen emits a line spectrum consisting of various series. Which series of hydrogen atomic spectra is lying in the visible region ?
(1) Brackett series (2) Paschen series
(3) Lyman series (4) Balmer series

10. Two identical photocathodes receive the light of frequencies f_1 and f_2 respectively. If the velocities of the photo-electrons coming out are v_1 and v_2 respectively, then
(1) $v_1^2 - v_2^2 = \frac{2h}{m}[f_1 - f_2]$ (3) $v_1 + v_2 = \left[\frac{2h}{m}(f_1 + f_2)\right]^{\frac{1}{2}}$
(2) $v_1^2 + v_2^2 = \frac{2h}{m}[f_1 + f_2]$ (4) $v_1 - v_2 = \left[\frac{2h}{m}(f_1 - f_2)\right]^{1/2}$

11. A particle of mass m moves in a circular orbit in a central potential field $U(r) = U_0 r^4$. If Bohr's quantization conditions are applied, radii of possible orbitals r_n vary with $n^{1/\alpha}$, where α is___________.

12. Imagine that the electron in a hydrogen atom is replaced by a muon (μ). The mass of muon particle is 207 times that of an electron and charge is equal to the charge of an electron. The ionization potential of this hydrogen atom will be :-
(1) 13.6 eV (2) 2815.2 eV
(3) 331.2 eV (4) 27.2 eV

13. A radioactive sample disintegrates via two independent decay processes having half lives $T_{1/2}^{(1)}$ and $T_{1/2}^{(2)}$ respectively. The effective half-life $T_{1/2}$ of the nuclei is :
(1) None of the above (2) $T_{1/2} = T_{1/2}^{(1)} + T_{1/2}^{(2)}$
(3) $T_{1/2} = \frac{T_{1/2}^{(1)}T_{1/2}^{(2)}}{T_{1/2}^{(1)} + T_{1/2}^{(2)}}$ (4) $T_{1/2} = \frac{T_{1/2}^{(1)} + T_{1/2}^{(2)}}{T_{1/2}^{(1)} - T_{1/2}^{(2)}}$

14. A particle is travelling 4 times as fast as an electron. Assuming the ratio of de-Broglie wavelength of a particle to that of electron is 2 : 1, the mass of the particle is :-
(1) $\frac{1}{16}$ times the mass of e^-
(2) 8 times the mass of e^-
(3) 16 times the mass of e^-
(4) $\frac{1}{8}$ times the mass of e^-

SOLUTION

15. The decay of a proton to neutron is :
(1) not possible as proton mass is less than the neutron mass
(2) possible only inside the nucleus
(3) not possible but neutron to proton conversion is possible
(4) always possible as it is associated only with β^+ decay

July Attempt

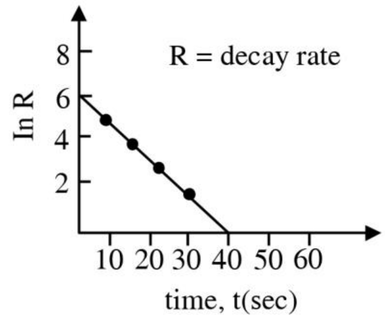
1. A radioactive material decays by simultaneous emissions of two particles with half lives of 1400 years and 700 years respectively. What will be the time after the which one third of the material remains ? (Take ln 3 = 1.1)
(1) 1110 years (2) 700 years
(3) 340 years (4) 740 years

2. A nucleus of mass M emits γ-ray photon of frequency 'ν'. The loss of internal energy by the nucleus is :
[Take 'c' as the speed of electromagnetic wave]
(1) $h\nu$ (2) 0
(3) $h\nu\left[1-\frac{h\nu}{2Mc^2}\right]$ (4) $h\nu\left[1+\frac{h\nu}{2Mc^2}\right]$

3. The radiation corresponding to $3 \rightarrow 2$ transition of a hydrogen atom falls on a gold surface to generate photoelectrons. These electrons are passed through a magnetic field of 5×10^{-4} T. Assume that the radius of the largest circular path followed by these electrons is 7 mm, the work function of the metal is :
(Mass of electron = 9.1×10^{-31} kg)
(1) 1.36 eV (2) 1.88 eV
(3) 0.16 eV (4) 0.82 eV

4. An electron having de-Broglie wavelength λ is incident on a target in a X-ray tube. Cut-off wavelength of emitted X-ray is :
(1) 0 (2) $\frac{2m^2c^2\lambda^2}{h^2}$
(3) $\frac{2mc\lambda^2}{h}$ (4) $\frac{hc}{mc}$

5. For a certain radioactive process the graph between ln R and t(sec) is obtained as shown in the figure. Then the value of half life for the unknown radioactive material is approximately :



(1) 9.15 sec (2) 6.93 sec
(3) 2.62 sec (4) 4.62 sec

6. A certain metallic surface is illuminated by monochromatic radiation of wavelength λ. The stopping potential for photoelectric current for this radiation is $3V_0$. If the same surface is illuminated with a radiation of wavelength 2λ, the stopping potential is V_0. The threshold wavelength of this surface for photoelectric effect is_____λ.

7. A radioactive substance decays to $\left(\frac{1}{16}\right)^{th}$ of its initial activity in 80 days. The half life of the radioactive substance expressed in days is____.

8. A nucleus with mass number 184 initially at rest emits an α-particle. If the Q value of the reaction is 5.5 MeV, calculate the kinetic energy of the α-particle.
(1) 5.0 MeV (2) 5.5 MeV
(3) 0.12 MeV (4) 5.38 MeV

9 An electron of mass m_e and a proton of mass m_P are accelerated through the same potential difference. The ratio of the de-Broglie wavelength associated with the electron to that with the proton is :-
(1) $\frac{m_P}{m_e}$ (2) 1 (3) $\sqrt{\frac{m_P}{m_e}}$ (4) $\frac{m_e}{m_p}$

SOLUTION

10. What should be the order of arrangement of de-Broglie wavelength of electron (λ_e), an α-particle (λ_α) and proton (λ_p) given that all have the same kinetic energy ?
(1) $\lambda_e = \lambda_p = \lambda_\alpha$ (2) $\lambda_e < \lambda_p < \lambda_\alpha$
(3) $\lambda_e > \lambda_p > \lambda_\alpha$ (4) $\lambda_e = \lambda_p > \lambda_\alpha$

11. A particle of mass 4M at rest disintegrates into two particles of mass M and 3M respectively having non zero velocities. The ratio of de-Broglie wavelength of particle of mass M to that of mass 3M will be :
(1) 1 : 3 (2) 3 : 1 (3) 1 : $\sqrt{3}$ (4) 1 : 1

12. Some nuclei of a radioactive material are undergoing radioactive decay. The time gap between the instances when a quarter of the nuclei have decayed and when half of the nuclei have decayed is given as :
(where λ is the decay constant)
(1) $\frac{1}{2}\frac{\ln 2}{\lambda}$ (2) $\frac{\ln 2}{\lambda}$
(3) $\frac{2\ln 2}{\lambda}$ (4) $\frac{\ln\frac{3}{2}}{\lambda}$

13. The half-life of ^{198}Au is 3 days. If atomic weight of ^{198}Au is 198 g/mol then the activity of 2 mg of ^{198}Au is [in disintegration/second] :
(1) 2.67×10^{12} (2) 6.06×10^{18}
(3) 32.36×10^{12} (4) 16.18×10^{12}

14. An electron moving with speed v and a photon moving with speed c, have same D-Broglie wavelength. The ratio of kinetic energy of electron to that of photon is :
(1) $\frac{3c}{v}$ (2) $\frac{v}{3c}$ (3) $\frac{v}{2c}$ (4) $\frac{2c}{v}$

15. When radiation of wavelength λ is incident on a metallic surface, the stopping potential of ejected photoelectrons is 4.8 V. If the same surface is illuminated by radiation of double the previous wavelength, then the stopping potential becomes 1.6 V. The threshold wavelength of the metal is :
(1) 2 λ (2) 4 λ (3) 8 λ (4) 6 λ

16. A light beam of wavelength 500 nm is incident on a metal having work function of 1.25 eV, placed in a magnetic field of intensity B. The electrons emitted perpendicular to the magnetic field B, with maximum kinetic energy are bent into circular arc of radius 30 cm. The value of B is _______ $\times 10^{-7}$ T.
Given hc = 20×10^{-26} J-m, mass of electron $= 9 \times 10^{-31}$ kg

17. From the given data, the amount of energy required to break the nucleus of aluminium $^{27}_{13}$Al is _____ x $\times 10^{-3}$ J.
Mass of neutron = 1.00866 u
Mass of proton = 1.00726 u
Mass of Aluminium nucleus = 27.18846 u
(Assume 1 u corresponds to x J of energy)
(Round off to the nearest integer)

18. The nuclear activity of a radioactive element becomes $\left(\frac{1}{8}\right)^{th}$ of its initial value in 30 years. The half-life of radioactive element is ________ years.

19. If 'f' denotes the ratio of the number of nuclei decayed (N_d) to the number of nuclei at t = 0 (N_0) then for a collection of radioactive nuclei, the rate of change of 'f' with respect to time is given as :
[λ is the radioactive decay constant]
(1) $-\lambda(1 - e^{-\lambda t})$ (2) $\lambda(1 - e^{-\lambda t})$
(3) $\lambda e^{-\lambda t}$ (4) $-\lambda e^{-\lambda t}$

20 In Bohr's atomic model, the electron is assumed to revolve in a circular orbit of radius 0.5 Å. If the speed of electron is 2.2×16^6 m/s, then the current associated with the electron will be ___________ $\times 10^{-2}$ mA. [Take π as $\frac{22}{7}$]

SOLUTION

21. A radioactive sample has an average life of 30 ms and is decaying. A capacitor of capacitance 200 μF is first charged and later connected with resistor 'R'. If the ratio of charge on capacitor to the activity of radioactive sample is fixed with respect to time then the value of 'R' should be ______Ω.

22. A particle of mass 9.1×10^{-31} kg travels in a medium with a speed of 10^6 m/s and a photon of a radiation of linear momentum 10^{-27} kg m/s travels in vacuum. The wavelength of photon is _______ times the wavelength of the particle.

23. An electron and proton are separated by a large distance. The electron starts approaching the proton with energy 3 eV. The proton captures the electrons and forms a hydrogen atom in second excited state. The resulting photon is incident on a photosensitive metal of threshold wavelength 4000 Å. What is the maximum kinetic energy of the emitted photoelectron?
(1) 7.61 eV
(2) 1.41 eV
(3) 3.3 eV
(4) No photoelectron would be emitted

24. Consider the following statements :
A. Atoms of each element emit characteristics spectrum.
B. According to Bohr's Postulate, an electron in a hydrogen atom, revolves in a certain stationary orbit.
C. The density of nuclear matter depends on the size of the nucleus.
D. A free neutron is stable but a free proton decay is possible.
E. Radioactivity is an indication of the instability of nuclei.
Choose the correct answer from the options given below :
(1) A, B, C, D and E
(2) A, B and E only
(3) B and D only
(4) A, C and E only

25. The K_α X-ray of molybdenum has wavelength 0.071 nm. If the energy of a molybdenum atoms with a K electron knocked out is 27.5 keV, the energy of this atom when an L electron is knocked out will be ______ keV. (Round off to the nearest integer)
[$h = 4.14 \times 10^{-15}$ eVs, $c = 3 \times 10^8$ ms^{-1}]

August Attempt

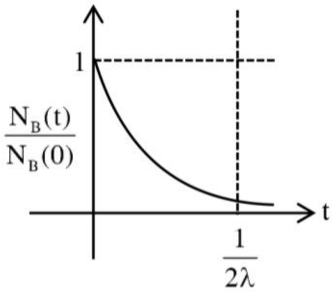
1. A particular hydrogen like ion emits radiation of frequency 2.92×10^{15} Hz when it makes transition from n = 3 to n = 1. The frequency in Hz of radiation emitted in transition from n = 2 to n = 1 will be :
(1) 0.44×10^{15} (2) 6.57×10^{15}
(3) 4.38×10^{15} (4) 2.46×10^{15}

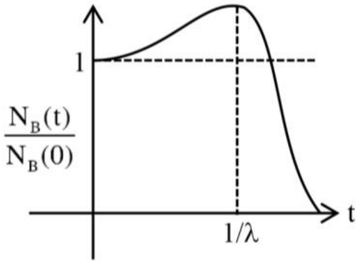
2. In a photoelectric experiment ultraviolet light of wavelength 280 nm is used with lithium cathode having work function $\phi = 2.5$ eV. If the wavelength of incident light is switched to 400 nm, find out the change in the stopping potential. ($h = 6.63 \times 10^{-34}$ Js, $c = 3 \times 10^8$ ms^{-1})
(1) 1.3 V (2) 1.1 V (3) 1.9 V (4) 0.6 V

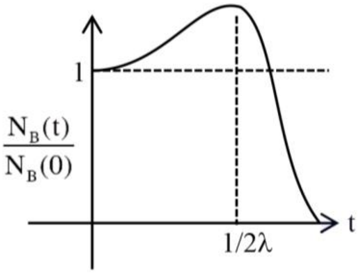
3. The de-Broglie wavelength of a particle having kinetic energy E is λ. How much extra energy must be given to this particle so that the de-Broglie wavelength reduces to 75% of the initial value ?
(1) $\frac{1}{9}E$ (2) $\frac{7}{9}E$
(3) E (4) $\frac{16}{9}E$

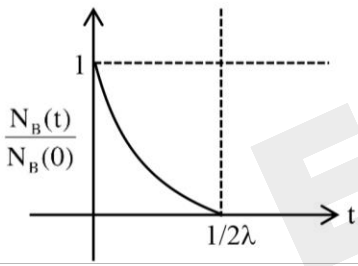
4. At time t = 0, a material is composed of two radioactive atoms A and B, where $N_A(0) = 2N_B(0)$. The decay constant of both kind of radioactive atoms is λ. However, A disintegrates to B and B disintegrates to C. Which of the following figures represents the evolution of $N_B(t) / N_B(0)$ with respect to time t ?
$\begin{bmatrix} N_A(0) = \text{No. of A atoms at } t = 0 \\ N_B(0) = \text{No. of B atoms at } t = 0 \end{bmatrix}$

SOLUTION

(1) 

(2) 

(3) 

(4) 

5. There are 10^{10} radioactive nuclei in a given radioactive element, Its half-life time is 1 minute. How many nuclei will remain after 30 seconds ?

$\left(\sqrt{2} = 1.414\right)$

(1) 2×10^{10} (2) 7×10^{9}

(3) 10^{5} (4) 4×10^{10}

6. In a photoelectric experiment, increasing the intensity of incident light :

(1) increases the number of photons incident and also increases the K.E. of the ejected electrons

(2) increases the frequency of photons incident and increases the K.E. of the ejected electrons.

(3) increases the frequency of photons incident and the K.E. of the ejected electrons remains unchanged

(4) increases the number of photons incident and the K.E. of the ejected electrons remains unchanged

7. A monochromatic neon lamp with wavelength of 670.5 nm illuminates a photo-sensitive material which has a stopping voltage of 0.48 V. What will be the stopping voltage if the source light is changed with another source of wavelength of 474.6 nm?

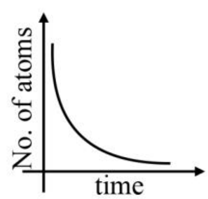
(1) 0.96 V (2) 1.25 V

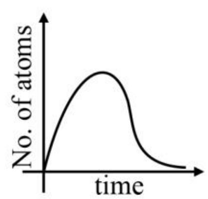
(3) 0.24 V (4) 1.5 V

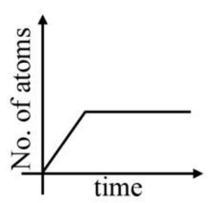
8. X different wavelengths may be observed in the spectrum from a hydrogen sample if the atoms are exited to states with principal quantum number n = 6 ? The value of X is _______.

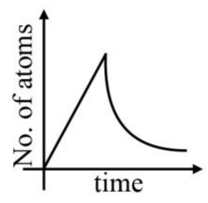
9. A sample of a radioactive nucleus A disintegrates to another radioactive nucleus B, which in turn disintegrates to some other stable nucleus C. Plot of a graph showing the variation of number of atoms of nucleus B vesus time is :

(Assume that at t = 0, there are no B atoms in the sample)

(1) 

(2) 

(3) 

(4) 

10. A moving proton and electron have the same de-Broglie wavelength. If K and P denote the K.E. and momentum respectively. Then choose the correct option :

(1) $K_p < K_e$ and $P_p = P_e$

(2) $K_p = K_e$ and $P_p = P_e$

(3) $K_p < K_e$ and $P_p < P_e$

(4) $K_p > K_e$ and $P_p = P_e$

SOLUTION

11. A free electron of 2.6 eV energy collides with a H^+ ion. This results in the formation of a hydrogen atom in the first excited state and a photon is released. Find the frequency of the emitted photon. ($h = 6.6 \times 10^{-34}$ Js)

(1) 1.45×10^{16} MHz (3) 1.45×10^{9} MHz

(2) 0.19×10^{15} MHz (4) 9.0×10^{27} MHz

12. Consider two separate ideal gases of electrons and protons having same number of particles. The temperature of both the gases are same. The ratio of the uncertainty in determining the position of an electron to that of a proton is proportional to :-

(1) $\left(\frac{m_p}{m_e}\right)^{3/2}$ (2) $\sqrt{\frac{m_e}{m_p}}$

(3) $\sqrt{\frac{m_p}{m_e}}$ (4) $\frac{m_p}{m_e}$

13. The temperature of an ideal gas in 3-dimensions is 300 K. The corresponding de-Broglie wavelength of the electron approximately at 300 K, is :

[m_e = mass of electron = 9×10^{-31} kg

h = Planck constant = 6.6×10^{-34} Js

k_B = Boltzmann constant = 1.38×10^{-23} JK^{-1}]

(1) 6.26 nm (2) 8.46 nm

(3) 2.26 nm (4) 3.25 nm

14. The half life period of radioactive element x is same as the mean life time of another radioactive element y. Initially they have the same number of atoms. Then :

(1) x–will decay faster than y.

(2) y– will decay faster than x.

(3) x and y have same decay rate initially and later on different decay rate.

(4) x and y decay at the same rate always.

SOLUTION

ANSWER KEY

Feb Attempt

1. 2
2. 1
3. 2
4. 4
5. 3
6. 4
7. 1
8. 3
9. 10
10. 4
11. 3
12. 1
13. 3
14. 1
15. 3
16. 2

March Attempt

1. 4
2. 15
3. 4
4. 2
5. 2
6. 2
7. 2
8. 2
9. 4
10. 1
11. 3
12. 2
13. 3
14. 4
15. 2

July Attempt

1. 4
2. 4
3. 4
4. 3
5. 4
6. 4
7. 20
8. 4
9. 3
10. 3
11. 4
12. 4
13. 4
14. 3
15. 2
16. 125
17. 27
18. 10
19. 3
20. 112
21. 150
22. 910
23. 2
24. 2
25. 10

August Attempt

1. 4
2. 1
3. 2
4. 3
5. 2
6. 4
7. 2
8. 15
9. 2
10. 1
11. 3
12. 3
13. 1
14. 2

1. Choose the correct option from the following options given below :

(A) In the ground state of Rutherford's model electrons are in stable equilibrium. While in Thomson's model electrons always experience a net-force.

(B) An atom has a nearly continuous mass distribution in a Rutherford's model but has a highly non-uniform mass distribution in Thomson's model

(C) A classical atom based on Rutherford's model is doomed to collapse.

(D) The positively charged part of the atom possesses most of the mass in Rutherford's model but not in Thomson's model.

2. Nucleus A is having mass number 220 and its binding energy per nucleon is 5.6 MeV. It splits in two fragments 'B' and 'C' of mass numbers 105 and 115. The binding energy of nucleons in 'B' and 'C' is 6.4 MeV per nucleon. The energy Q released per fission will be :

(A) 0.8 MeV (B) 275 MeV

(C) 220 MeV (D) 176 MeV

3. When light of frequency twice the threshold frequency is incident on the metal plate, the maximum velocity of emitted election is v_1. When the frequency of incident radiation is increased to five times the threshold value, the maximum velocity of emitted electron becomes v_2. If $v_2 = x\, v_1$, the value of x will be ______.

4. The light of two different frequencies whose photons have energies 3.8 eV and 1.4 eV respectively, illuminate a metallic surface whose work function is 0.6 eV successively. The ratio of maximum speeds of emitted electrons for the two frequencies respectivly will be :

(A) 1 : 1 (B) 2 : 1

(C) 4 : 1 (D) 1 : 4

5. In Bohr's atomic model of hydrogen, let K. P and E are the kinetic energy, potential energy and total energy of the electron respectively. Choose the correct option when the electron undergoes transitions to a higher level :

(A) All K. P and E increase.

(B) K decreases. P and E increase.

(C) P decreases. K and E increase.

(D) K increases. P and E decrease.

6. A sample contains 10^{-2} kg each of two substances A and B with half lives 4 s and 8 s respectively. The ratio of then atomic weights is 1 : 2. The ratio of the amounts of A and B after 16 s is $\frac{x}{100}$. the value of x is ________.

7. **Statement I :** Davisson-Germer experiment establishes the wave nature of electrons.

Statement II : If electrons have wave nature, they can interfere and show diffraction.

In the light of the above statements choose the **correct answer** from the options given below:-

(A) Both **Statement I** and **Statement II** are true

(B) Both **Statement I** and **Statement II** are false

(C) **Statement I** is true but **Statement II** is false

(D) **Statement I** is false but **Statement II** is true

8. The ratio for the speed of the electron in the 3rd orbit of He^+ to the speed of the electron in the 3rd orbit of hydrogen atom will be :-

(A) 1 : 1 (B) 1 : 2

(C) 4 : 1 (D) 2 : 1

SOLUTION

9. A proton, a neutron, an electron and an α-particle have same energy. If $\lambda_p, \lambda_n, \lambda_e$ and λ_α are the de Broglie's wavelengths of proton, neutron, electron and α particle respectively, then choose the correct relation from the following :

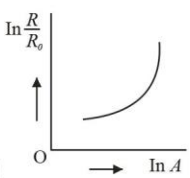
(A) $\lambda_p = \lambda_n > \lambda_e > \lambda_\alpha$

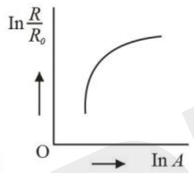
(B) $\lambda_\alpha < \lambda_n < \lambda_p < \lambda_e$

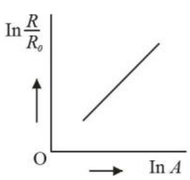
(C) $\lambda_e < \lambda_p = \lambda_n > \lambda_\alpha$

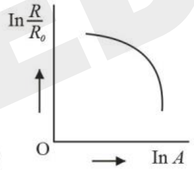
(D) $\lambda_e = \lambda_p = \lambda_n = \lambda_\alpha$

10. Which of the following figure represents the variation of $\ln\left(\frac{R}{R_0}\right)$ with lnA(If R = radius of a nucleus and A = its mass number)

(A)


(C)


(B)


(D)


11. An electron with speed v and a photon with speed c have the same de-Broglie wavelength. If the kinetic energy and momentum of electron are E_e and p_e and that of photon are E_{ph} and p_{ph} respectively. Which of the following is correct?

(A) $\frac{E_e}{E_{ph}} = \frac{2c}{v}$ (B) $\frac{E_e}{E_{ph}} = \frac{v}{2c}$

(C) $\frac{p_e}{p_{ph}} = \frac{2c}{v}$ (D) $\frac{p_e}{p_{ph}} = \frac{v}{2c}$

12. How many alpha and beta particles are emitted when Uranium $_{92}U^{238}$ decays to lead $_{82}Pb^{206}$?

(A) 3 alpha particles and 5 beta particles

(B) 6 alpha particles and 4 beta particles

(C) 4 alpha particles and 5 beta particles

(D) 8 alpha particles and 6 beta particles

13. A metal surface is illuminated by a radiation of wavelength 4500 Å. The ejected photo-electron enters a constant magnetic field of 2 mT making an angle of 90° with the magnetic field. If it starts revolving in a circular path of radius 2 mm, the work function of the metal is approximately :

(A) 1.36 eV (B) 1.69 eV (C) 2.78 eV (D) 2.23 eV

14. A radioactive nucleus can decay by two different processes. Half-life for the first process is 3.0 hours while it is 4.5 hours for the second process. The effective half- life of the nucleus will be :

(A) 3.75 hours (B) 0.56 hours

(C) 0.26 hours (D) 1.80 hours

15. The stopping potential for photoelectrons emitted from a surface illuminated by light of wavelength 6630 Å is 0.42 V. If the threshold frequency is x × 10^{13}/s, where x is _______ (nearest integer).

(Given, speed light = 3 × 10^8 m/s, Planck's constant = 6.63 × 10^{-34} Js)

16. An a particle and a carbon 12 atom has same kinetic energy K. The ratio of their de-Broglie wavelength $(\lambda_\alpha : \lambda_{C12})$ is :

(A) $1:\sqrt{3}$ (B) $\sqrt{3}:1$

(C) 3 : 1 (D) $2:\sqrt{3}$

SOLUTION

17. A hydrogen atom in is ground state absorbs 10.2 eV of energy. The angular momentum of electron of the hydrogen atom will increase by the value of: (Given, Plank's constant = 6.6×10^{-34} Js)

(A) $2.10\times10^{-34}\,Js$ (B) $1.05\times10^{-34}\,Js$

(C) $3.15\times10^{-34}\,Js$ (D) $4.2\times10^{-34}\,Js$

18. A beam of monochromatic light is used to excite the electron in Li^{++} from the first orbit to the third orbit. The wavelength of monochromatic light is found to be $x\times10^{-10}m$. The value of x is ______ . [Given hc = 1242 eV nm]

19. **Statement I :** In hydrogen atom, the frequency of radiation emitted when an electron jumps from lower energy orbit (E_1) to higher energy orbit (E_2), is given as $hf = E_1 - E_2$.

Statement-II : The jumping of electron from higher energy orbit (E_2) to lower energy orbit (E_1) is associated with frequency of radiation given as $f = (E_2 - E_1)/h$

This condition is Bohr's frequency condition.

In the light of the above statements, choose the correct answer from the options given below:

(A) Both statement I and statement II are true.

(B) Both statement I and statement II are false

(C) Statement I is correct but statement II is false

(D) Statement I is incorrect but statement II is true.

20 The de Brogue wavelengths for an electron and a photon are λ_e and λ_p respectively. For the same kinetic energy of electron and photon. which of the following presents the correct relation between the de Brogue wavelengths of two ?

(A) $\lambda_p \propto \lambda_e^2$ (B) $\lambda_p \propto \lambda_e$

(C) $\lambda_p \propto \sqrt{\lambda_e}$ (D) $\lambda_p \propto \sqrt{\frac{1}{\lambda_e}}$

21. The Q-value of a nuclear reaction and kinetic energy of the projectile particle, K_p are related as :

(A) $Q = K_p$

(B) $(K_p + Q) < O$

(C) $Q < K_p$

(D) $(K_p + Q) > 0$

22. Let K_1 and K_2 be the maximum kinetic energies of photo–electrons emitted when two monochromatic beams of wavelength λ_1 and λ_2, respectively are incident on a metallic surface. If $\lambda_1 = 3\lambda_2$ then:

(A) $K_1 > \frac{K_2}{3}$ (C) $K_1 = \frac{K_2}{3}$

(B) $K_1 < \frac{K_2}{3}$ (D) $K_2 = \frac{K_1}{3}$

23. Following statements related to radioactivity are given below:

(A) Radioactivity is a random and spontaneous process and is dependent on physical and chemical conditions.

(B) The number of un–decayed nuclei in the radioactive sample decays exponentially with time.

(C) Slope of the graph of $\log_e$(no. of undecayed nuclei) Vs. time represents the reciprocal of mean life time (τ).

(D) Product of decay constant (λ) and half–life time ($T_{1/2}$) is not constant.

Choose the most appropriate answer from the options given below:

(A) (A) and (B) only

(B) (B) and (D) only

(C) (B) and (C) only

(D) (C) and (D) only

SOLUTION

24. The activity of a radioactive material is 2.56×10^{-3} Ci. If the half life of the material is 5 days, after how many days the activity will become 2×10^{-5} Ci?

(A) 30 days (B) 35 days

(C) 40 days (D) 25 days

25. **Assertion A :** The photoelectric effect does not take place, if the energy of the incident radiation is less than the work function of a metal.

Reason R : Kinetic energy of the photoelectrons is zero, if the energy of the incident radiation is equal to the work function of a metal.

In the light of the above statements, choose the **most appropriate** answer from the options given below.

(A) Both **A** and **R** are correct and **R** is the correct explanation of **A**

(B) Both **A** and **R** are correct but **R** is not the correct explanation of **A**

(C) **A** is correct but **R** is not correct

(D) **A** is not correct but **R** is correct

26. $\sqrt{d_1}$ and $\sqrt{d_2}$ are the impact parameters corresponding to scattering angles 60° and 90° respectively, when an α particle is approaching a gold nucleus. For $d_1 = x\ d_2$, the value of x will be_______.

In the following nuclear rection,

27. $D \xrightarrow{\alpha} D_1 \xrightarrow{\beta^-} D_2 \xrightarrow{\alpha} D_3 \xrightarrow{\gamma} D_4$

Mass number of D is 182 and atomic number is 74. Mass number and atomic number of D_4 respectively will be___.

(A) 174 and 71 (B) 174 and 69

(C) 172 and 69 (D) 172 and 71

28. The electric field at the point associated with a light wave is given by

$E = 200\ [\sin(6 \times 10^{15})\ t + \sin(9 \times 10^{15})\ t]\ Vm^{-1}$

Given : $h = 4.14 \times 10^{-15}$ eVs

If this light falls on a metal surface having a work function of 2.50 eV, the maximum kinetic energy of the photoelectrons will be :

(A) 1.90 eV (B) 3.27 eV

(C) 3.60 eV (D) 3.42 eV

29. The half life of a radioactive substance is 5 years. After x years a given sample of the radioactive substance gest reduced to 6.25% of its initial value of x is _______.

SOLUTION

Answer Key

1. C
2. D
3. 2
4. B
5. B
6. 25
7. A
8. D
9. B
10. B
11. B
12. D
13. A
14. D
15. 35
16. B
17. B
18. 114
19. D
20. A
21. D
22. B
23. C
24. B
25. B
26. 3
27. A
28. D
29. 20

1. A metal exposed to light of wavelength 800 nm and emits photoelectrons with a certain kinetic energy. The maximum kinetic energy of photo-electron doubles when light of wavelength 500 nm is used. The work function of the metal is (Take hc = 1230 eV-nm).

(A) 1.537 eV (B) 2.46 eV

(C) 0.615 eV (D) 1.23 eV

2. The momentum of an electron revolving in n^{th} orbit is given by : (Symbols have their usual meanings)

(A) $\frac{nh}{2\pi r}$ (B) $\frac{nh}{2r}$

(C) $\frac{nh}{2\pi}$ (D) $\frac{2\pi r}{nh}$

3. The ratio of wavelengths of proton and deuteron accelerated by potential V_p and V_d is $1:\sqrt{2}$. Then, the ratio of V_p to V_d will be

(A) 1 : 1 (B) $\sqrt{2}:1$

(C) 2 : 1 (D) 4 : 1

4. Hydrogen atom from excited state comes to the ground by emitting a photon of wavelength λ. The value of principal quantum number 'n' of the excited state will be :

(R : Rydberg constant)

(A) $\sqrt{\frac{\lambda R}{\lambda - 1}}$ (B) $\sqrt{\frac{\lambda R}{\lambda R - 1}}$

(C) $\sqrt{\frac{\lambda}{\lambda R - 1}}$ (D) $\sqrt{\frac{\lambda R^2}{\lambda R - 1}}$

5. $\frac{x}{x+4}$ is the ratio of energies of photons produced due to transition of an electron of hydrogen atom from its

(i) third permitted energy level to the second level and

(ii) the highest permitted energy level to the second permitted level.

The value of x will be

6. The disintegration rate of a certain radioactive sample at any instant is 4250 disintegrations per minute. 10 minutes later, the rate becomes 2250 disintegrations per minute. The approximate decay constant is :

(Take $\log_{10}1.88 = 0.274$)

(A) 0.02 min^{-1} (B) 2.7 min^{-1}

(C) 0.063 min^{-1} (D) 6.3 min^{-1}

7. A parallel beam of light of wavelength 900 nm and intensity 100 Wm^{-2} is incident on a surface perpendicular to the beam. Tire number of photons crossing 1 cm^2 area perpendicular to the beam in one second is :

(A) 3×10^{16} (B) 4.5×10^{16}

(C) 4.5×10^{17} (D) 4.5×10^{20}

8. In a hydrogen spectrum , λ be the wavelength of first transition line of Lyman series. The wavelength difference will be "$a\lambda$" between the wavelength of 3^{rd} transition line of Paschen series and that of 2^{nd} transition line of Balmer Series where a = ________

9. A nucleus of mass M at rest splits into two parts having masses $\frac{M'}{3}$ and $\frac{2M'}{3}$ $(M' < M)$. The ratio of de Broglie wavelength of two parts will be :

(A) 1 : 2 (B) 2 : 1

(C) 1 : 1 (D) 2 : 3

10. Mass numbers of two nuclei are in the ratio of 4:3. Their nuclear densities will be in the ratio of

(A) 4:3 (B) $\left(\frac{3}{4}\right)^{\frac{1}{3}}$

(C) 1 : 1 (D) $\left(\frac{4}{3}\right)^{\frac{1}{3}}$

SOLUTION

11. Two lighter nuclei combine to form a comparatively heavier nucleus by the relation given below:

$^2_1X + ^2_1X = ^4_2Y$

The binding energies per nucleon ^2_1X and ^4_2Y are 1.1 MeV and 7.6 MeV respectively. The energy released in this process is_______ . MeV.

12. An electron (mass m) with an initial velocity $\vec{v} = v_0\hat{i}(v_0 > 0)$ is moving in an electric field $\vec{E} = -E_0\hat{i}(E_0 > 0)$ where E_0 is constant. If at t = 0 de Broglie wavelength is $\lambda_0 = \frac{h}{mv_0}$, then its de Broglie wavelength after time t is given by

(A) λ_0
(B) $\lambda_0\left(1 + \frac{eE_0t}{mv_0}\right)$
(C) $\lambda_0 t$
(D) $\frac{\lambda_0}{\left(1 + \frac{eE_0t}{mv_0}\right)}$

13. What is the half-life period of a radioactive material if its activity drops to 1/16th of its initial value of 30 years ?

(A) 9.5 years
(B) 8.5 years
(C) 7.5 years
(D) 10.5 years

14. With reference to the observations in photo-electric effect, identify the correct statements from below:

A. The square of maximum velocity of photoelectrons varies linearly with frequency of incident light.

B. The value of saturation current increases on moving the source of light away from the metal surface.

C. The maximum kinetic energy of photo-electrons decreases on decreasing the power of LED (light emitting diode) source of light.

D. The immediate emission of photo-electrons out of metal surface can not be explained by particle nature of light/electromagnetic waves.

E. Existence of threshold wavelength can not be explained by wave nature of light/electromagnetic waves.

Choose the correct answer from the options given below:

(A) A and B only
(B) A and E only
(C) C and E only
(D) D and E only

15. The activity of a radioactive material is 6.4×10^{-4} curie. Its half life is 5 days. The activity will become 5×10^{-6} curie after :

(A) 7 days
(B) 15 days
(C) 25 days
(D) 35 days

16. The equation $\lambda = \frac{1.227}{x}$nm can be used to find the de-Brogli wavelength of an electron. In this equation x stands for :

Where,

m = mass of electron

P = momentum of electron

K = Kinetic energy of electron

V = Accelerating potential in volts for electron

(A) $\sqrt{mK}$
(B) $\sqrt{P}$
(C) $\sqrt{K}$
(D) $\sqrt{V}$

17. The half life period of a radioactive substance is 60 days. The time taken for $\frac{7}{8}$th of its original mass to disintegrate will be :

(A) 120 days
(B) 130 days
(C) 180 days
(D) 20 days

18. A freshly prepared radioactive source of half life 2 hours 30 minutes emits radiation which is 64 times the permissible safe level. The minimum time, after which it would be possible to work safely with source, will be ________ hours.

SOLUTION

19. Sun light falls normally on a surface of area 36 cm^2 and exerts an average force of 7.2×10^{-9} N within a time period of 20 minutes. Considering a case of complete absorption, the energy flux of incident light is
(A) 25.92×10^{2} W/cm^2
(B) 8.64×10^{-6} W/cm^2
(C) 6.0 W/cm^2
(D) 0.06 W/cm^2

20. Two streams of photons, possessing energies to five and ten times the work function of metal are incident on the metal surface successively. The ratio of the maximum velocities of the photoelectron emitted, in the two cases respectively, will be
(A) 1 : 2 (B) 1 : 3
(C) 2 : 3 (D) 3 : 2

21. A radioactive sample decays $\frac{7}{8}$ times its original quantity in 15 minutes. The half-life of the sample is
(A) 5 min (B) 7.5 min
(C) 15 min (D) 30 min

22. The kinetic energy of emitted electron is E when the light incident on the metal has wavelength λ. To double the kinetic energy, the incident light must have wavelength :
(A) $\frac{hc}{E\lambda - hc}$ (B) $\frac{hc\lambda}{E\lambda + hc}$
(C) $\frac{h\lambda}{E\lambda + hc}$ (D) $\frac{hc\lambda}{E\lambda - hc}$

23. Find the ratio of energies of photons produced due to transition of an election of hydrogen atom from its(i) second permitted energy level to the first level, and (ii) the highest permitted energy level to the first permitted level.
(A) 3 :4 (B) 4 : 3
(C) 1 : 4 (D) 4 : 1

24. Read the following statements:
(A) Volume of the nucleus is directly proportional to the mass number.
(B) Volume of the nucleus is independent of mass number.
(C) Density of the nucleus is directly proportional to the mass number.
(D) Density of the nucleus is directly proportional to the cube root of the mass number.
(E) Density of the nucleus is independent of the mass number.
Choose the correct option from the following options.
(A) (A) and (D) only. (B) (A) and (E) only.
(C) (B) and (E) only. (D) (A) and (C) only

25. Two radioactive materials A and B have decay constants 25λ and 16λ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of B to that of A will be "e" after a time $\frac{1}{a\lambda}$. The value of a is_______.

SOLUTION

ANSWER KEY

1. C
2. A
3. D
4. B
5. 5
6. C
7. B
8. 5
9. C
10. C
11. 26
12. D
13. C
14. B
15. D
16. D
17. C
18. 15
19. D
20. C
21. A
22. B
23. A
24. B
25. 9

1. A proton moving with one tenth of velocity of light has a certain de Broglie wavelength of λ. An alpha particle having certain kinetic energy has the same de-Broglie wavelength λ. The ratio of kinetic energy of proton and that of alpha particle is:
   (1) 2 : 1
   (2) 4 : 1
   (3) 1 : 2
   (4) 1 : 4

2. The mass of proton, neutron and helium nucleus are respectively 1.0073 u, 1.0087 u and 4.0015u. The binding energy of helium nucleus is:
   (1) 14.2 MeV
   (2) 28.4 MeV
   (3) 56.8 MeV
   (4) 7.1 MeV

3. A light of energy 12.75 eV is incident on a hydrogen atom in its ground state. The atom absorbs the radiation and reaches to one of its excited states. The angular momentum of the atom in the excited state is $\frac{x}{\pi} \times 10^{-17}$ eVs. The value of x is ________ (use $h = 4.14 \times 10^{-15}$eVs, $c = 3 \times 10^{8}$ ms^{-1}).

4. An electron of a hydrogen like atom, having Z = 4, jumps from 4th energy state to 2nd energy state, The energy released in this process, will be:
   (Given Rch = 13.6 eV)
   Where R = Rydberg constant
   c = Speed of light in vacuum
   h = Planck's constant
   (1) 13.6 eV
   (2) 10.5 eV
   (3) 3.4 eV
   (4) 40.8 eV

5. The threshold frequency of metal is f_0. When the light of frequency $2f_0$ is incident on the metal plate, the maximum velocity of photoelectron is ν_1. When the frequency of incident radiation is increased to $5f_0$. the maximum velocity of photoelectrons emitted is ν_2. The ratio of ν_1 to ν_2 is:
   (1) $\frac{\nu_1}{\nu_2} = \frac{1}{2}$ (2) $\frac{\nu_1}{\nu_2} = \frac{1}{8}$
   (3) $\frac{\nu_1}{\nu_2} = \frac{1}{16}$ (4) $\frac{\nu_1}{\nu_2} = \frac{1}{4}$

6. Nucleus a having Z = 17 and equal number of protons and neutrons has 1.2 MeV binding energy per nucleon.
   Another nucleus B of Z = 12 has total 26 nucleons and 1.8 MeV binding energy per nucleons.
   The difference of binding energy of B and A will be ____MeV.

7. From the photoelectric effect experiment, following observations are made. Identify which of these are correct
   A. The stopping potential depends only on the work function of the metal.
   B. The saturation current increases as the intensity of incident light increases.
   C. The maximum kinetic energy of a photo electron depends on the intensity of the incident light.
   D. Photoelectric effect can be explained using wave theory of light.
   Choose the correct answer from the options given below:
   (1) B, C only (2) A, C, D only
   (3) B only (4) A, B, D only

8. Consider the following radioactive decay process
   $^{218}_{84}A \xrightarrow{\alpha} A_1 \xrightarrow{\beta^-} A_2 \xrightarrow{\gamma} A_3 \xrightarrow{\alpha} A_4 \xrightarrow{\beta^+} A_5 \xrightarrow{\gamma} A_6$
   The mass number and the atomic number A_6 are given by :
   (1) 210 and 82 (2) 210 and 84
   (3) 210 and 80 (4) 211 and 80

SOLUTION

9. Assume that protons and neutrons have equal masses. Mass of a nucleon is 1.6×10^{-27} kg and radius of nucleus is 1.5×10^{-15} $A^{1/3}$ m. The approximate ratio of the nuclear density and water density is $n \times 10^{13}$. The value of n is _______ .

10. An α-particle, a proton and an electron have the same kinetic energy. Which one of the following is correct in case of their De-Broglie wavelength:
(1) $\lambda_\alpha > \lambda_p > \lambda_e$
(2) $\lambda_\alpha < \lambda_p < \lambda_e$
(3) $\lambda_\alpha = \lambda_p = \lambda_e$
(4) $\lambda_\alpha > \lambda_p < \lambda_e$

11. A photon is emitted in transition from n = 4 to n=1 level in hydrogen atom. The corresponding wavelength for this transition is
(given, $h = 4 \times 10^{-15}$ eVs) :
(1) 94.1 nm
(2) 941 nm
(3) 97.4 nm
(4) 99.3 nm

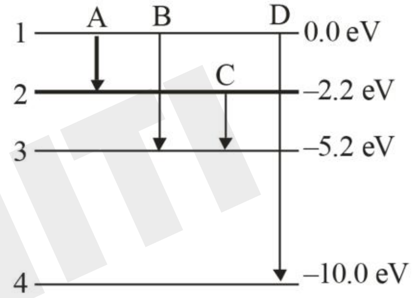
12. The energy released per fission of nucleus of ^{240}X is 200 MeV. The energy released if all the atoms in 120g of pure ^{240}X undergo fission is _____ $\times 10^{25}$ MeV.
(Given $N_A = 6 \times 10^{23}$)

13. Electron beam used in an electron microscope, when accelerated by a voltage of 20 kV. has a de-Broglie wavelength of λ_0. If the voltage is increased to 40 kV. then the de-Broglie wavelength associated with the electron beam would be:
(1) $3\lambda_0$ (2) $9\lambda_0$
(3) $\frac{\lambda_0}{2}$ (4) $\frac{\lambda_0}{\sqrt{2}}$

14. The ratio of the density of oxygen nucleus $\left(^{16}_{8}O\right)$ and helium nucleus $\left(^{4}_{2}He\right)$ is
(1) 4:1 (2) 8:1
(3) 1:1 (4) 2:1

15. The wavelength of the radiation emitted is λ_0 when an electron jumps from the second excited state to the first excited state of hydrogen atom. If the electron jumps from the third excited state to the second orbit of the hydrogen atom, the wavelength of the radiation emitted will be $\frac{20}{x}\lambda_0$. The value of x is_____.

16. The energy levels of an atom is shown is figure. Which one of these transitions will result in the emission of a photon of wavelength 124.1 nm ? Given ($h = 6.62 \times 10^{-34}$ Js)



(1) B (2) A
(3) C (4) D

17. Given below are two statements :
Statement I : Stopping potential in photoelectric effect does not depend on the power of the light source.
Statement II : For a given metal, the maximum kinetic energy of the photoelectron depends on the wavelength of the incident light.
In the light of above statements, choose the most appropriate answer from the options given below.
Options :
(1) Statement I is incorrect but statement II is correct
(2) Both Statement I and Statement II are incorrect
(3) Statement I is correct but statement II is incorrect
(4) Both statement I and statement II are correct

SOLUTION

18. A nucleus disintegrates into two smaller parts, which have their velocities in the ratio 3 : 2. The ratio of their nuclear sizes will be $\left(\frac{x}{3}\right)^{\frac{1}{3}}$. The value of 'x' is :

19. The threshold wavelength for photoelectric emission from a material is 5500Å. Photoelectrons will be emitted, when this material is illuminated with monochromatic radiation from a

A. 75 W infra-red lamp

B. 10 W infra-red lamp

C. 75 W ultra-violet lamp

D. 10 W ultra-violet lamp

Choose the correct answer from the options given below :

(1) B and C only (2) A and D only

(3) C only (4) C and D only

20. If a radioactive element having half-life of 30 min is undergoing beta decay, the fraction of radioactive element remains undecayed after 90 min. will be :

(1) $\frac{1}{8}$ (2) $\frac{1}{16}$

(3) $\frac{1}{4}$ (4) $\frac{1}{2}$

21. A radioactive element $^{242}_{92}X$ emits two α-particles, one electron and two positrons. The product nucleus is represented by $^{234}_{P}Y$. The value of P is ____

22. Substance A has atomic mass number 16 and half life of 1 day. Another substance B has atomic mass number 32 and half life of $\frac{1}{2}$ day. If both A and B simultaneously start undergo radio activity at the same time with initial mass 320 g each, how many total atoms of A and B combined would be left after 2 days.

(1) 3.38×10^{24}

(2) 6.76×10^{24}

(3) 6.76×10^{23}

(4) 1.69×10^{24}

23. The ratio of de-Broglie wavelength of an α-particle and a proton accelerated from rest by the same potential is $\frac{1}{\sqrt{m}}$, the value of m is

(1) 4 (2) 16

(3) 8 (4) 2

24. A small object at rest, absorbs a light pulse of power 20 mW and duration 300 ns. Assuming speed of light as 3×10^8 m/s. the momentum of the object becomes equal to :

(1) 0.5×10^{-17} kg m/s (2) 2×10^{-17} kg m/s

(3) 3×10^{-17} kg m/s (4) 1×10^{-17} kg m/s

25. Speed of an electron in Bohr's 7th orbit for Hydrogen atom is 3.6×10^6 m/s. The corresponding speed of the electron in 3rd orbit, in m/s is :

(1) (1.8×10^6) (2) (7.5×10^6)

(3) (3.6×10^6) (4) (8.4×10^6)

26. A point source of light is placed at the centre of curvature of a hemispherical surface. The source emits a power of 24 W The radius of curvature of hemisphere is 10 cm and the inner surface is completely reflecting. The force on the hemisphere due to the light falling on it is _______ $\times 10^{-8}$ N.

SOLUTION

27. Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : The nuclear density of nuclides $^{10}_{5}B$, $^{6}_{3}Li$, $^{56}_{26}Fe$, $^{20}_{10}Ne$ and $^{209}_{83}Bi$ can be arranged as $\rho^N_{Bi} > \rho^N_{Fe} > \rho^N_{Ne} > \rho^N_{B} > \rho^N_{Li}$.

Reason R : The radius R of nucleus is related to its mass number A as $R = R_0 A^{1/3}$, where R_0 is a constant.

In the light of the above statement, choose the **correct** answer from the options given below :

(1) Both **A** and **R** are true and R is the correct explanation of **A**

(2) **A** is false but **R** is true

(3) **A** is true but **R** is false

(4) Both **A** and **R** are true but **R** is **NOT** the correct explanation of **A**

28. An electron accelerated through a potential difference V_1 has a de-Broglie wavelength of λ. When the potential is changed to V_2, its de-Broglie wavelength increases by 50%. The value of $\left(\frac{V_1}{V_2}\right)$ is equal to :

(1) 3 (2) $\frac{9}{4}$

(3) $\frac{3}{2}$ (4) 4

29. A radioactive nucleus decays by two different process. The half life of the first process is 5 minutes and that of the second process is 30s. The effective half-life of the nucleus is calculated to be $\frac{\alpha}{11}$ s. The value of α is _______.

30. A free neutron decays into a proton but a free proton does not decay into neutron. This is because

(1) neutron is an uncharged particle

(2) proton is a charged particle

(3) neutron is a composite particle made of a proton and an electron

(4) neutron has larger rest mass than proton

31. Given below are two statements: One is labelled as **Assertion A** and the other is labelled as **Reason R**

Assertion A: The beam of electrons shows wave nature and exhibit interference and diffraction.

Reason R : Davisson Germer Experimentally verified the wave nature of electrons.

In the light of the above statements. Choose the **most appropriate** answer from the options given below :

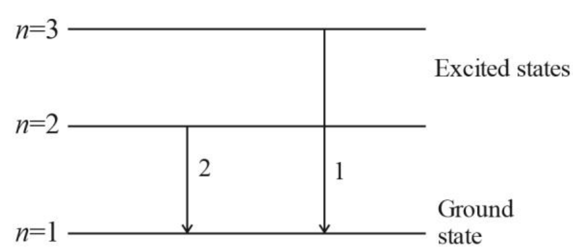
(1) A is correct but R is not correct

(2) A is not correct but R is correct

(3) Both A and R are correct but R is Not the correct explanation of A

(4) Both A and R are correct and R is the correct explanation of A

32. For hydrogen atom, λ_1 and λ_2 are the wavelengths corresponding to the transitions 1 and 2 respectively as shown in figure. The ratio of λ_1 and λ_2 is $\frac{x}{32}$. The value of x is ______.



SOLUTION

33. If the two metals A and B are exposed to radiation of wavelength 350 nm. The work functions of metals A and B are 4.8 eV and 2.2 eV. Then choose the correct option

(1) Metal B will not emit photo-electrons

(2) Both metals A and B will emit photo-electrons

(3) Both metals A and B will not emit photo-electrons

(4) Metal A will not emit photo-electrons

34. The radius of electron's second stationary orbit in Bohr's atom is R. The radius of 3rd orbit will be

(1) $\frac{R}{3}$ (2) 2.25R

(3) 3R (4) 9R

35. If the binding energy of ground state electron in a hydrogen atom is 13.6 eV, then, the energy required to remove the electron from the second excited state of Li^{2+} will be: $x \times 10^{-1}$ eV. The value of x is _______.

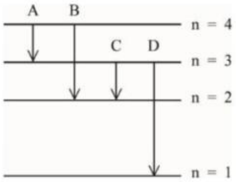
SOLUTION

ANSWER KEY

1. 2
2. 2
3. 828
4. 4
5. 1
6. 6
7. 3
8. 3
9. 11
10. 2
11. 1
12. 6
13. 4
14. 3
15. 27
16. 4
17. 4
18. 2
19. 4
20. 1
21. 87
22. 1
23. 3
24. 2
25. 4
26. 4
27. 2
28. 2
29. 300
30. 4
31. 4
32. 27
33. 4
34. 2
35. 136

1. The kinetic energy of an electron, α-particle and a proton are given as 4K, 2K and K respectively. The de-Broglie wavelength associated with electron (λe) α-particle ($\lambda\alpha$) and the proton (λp) are as follows :
(1) $\lambda\alpha = \lambda p < \lambda e$
(2) $\lambda\alpha > \lambda p > \lambda e$
(3) $\lambda\alpha < \lambda p < \lambda e$
(4) $\lambda\alpha = \lambda p > \lambda e$

2. The energy levels of an hydrogen atom are shown below. The transition corresponding to emission of shortest wavelength is



(1) C (2) D
(3) B (4) A

3. The radius of fifth orbit of the Li^{++} is ____ $\times 10^{-12}$ m.
Take : radius of hydrogen atom = 0.51Å

4. The work functions of Aluminium and Gold are 4.1 eV and and 5.1 eV respectively. The ratio of the slope of the stopping potential versus frequency plot for Gold to that of Aluminium is
(1) 1.24 (2) 2
(3) 1 (4) 1.5

5. A small particle of mass m moves in such a way that its potential energy $U = \frac{1}{2}m\omega^2 r^2$ where ω is constant and r is the distance of the particle from origin. Assuming Bohr's quantization of momentum and circular orbit, the radius of n^{th} orbit will be proportional to.
(1) $\sqrt{n}$ (3) n^2
(2) n (4) $\frac{1}{n}$

6. Experimentally it is found that 12.8 eV energy is required to separate a hydrogen atom into a proton and an electron. So the orbital radius of the electron in a hydrogen atom is $\frac{9}{x}\times 10^{-10}$ m. The value of the x is ________.
($1eV = 1.6 \times 10^{-19}J$, $\frac{1}{4\pi\epsilon_0} = 9\times 10^9 Nm^2/C^2$ and electronic charge $= 1.6 \times 10^{-19}$J C)

7. For a nucleus ^A_ZX having mass number A and atomic number Z
A. The surface energy per nucleon $(b_s) = a_1A^{2/3}$
B. The Coulomb contribution to the binding energy $b_c = -a_2\frac{Z(Z-1)}{A^{4/3}}$
C. The volume energy $b_v = a_3A$
D. Decrease in the binding energy is proportional to surface area.
E. While estimating the surface energy, it is assumed that each nucleon interacts with 12 nucleons, (a_1, a_2 and a_3 are constants)
Choose the **most appropriate** answer from the options given below:
(1) C, D only (2) B, C, E only
(3) A, B, C, D only (4) B, C only

8. Proton (P) and electron (e) will have same de-Broglie wavelength when the ratio of their momentum is (assume, $m_p = 1849m_e$)
(1) 1: 43 (2) 43 : 1
(3) 1 : 1849 (4) 1 : 1

SOLUTION

9. A nucleus with mass number 242 and binding energy per nucleon as 7.6 MeV breaks into fragment each with mass number 121. If each fragment nucleus has binding energy per nucleon as 8.1 MeV, the total gain in binding energy is ____MeV

10. A radio-active material is reduced to 1/8 of its original amount in 3 days. If 8×10^{-3} kg of the material is left after 5 days. The initial amount of the material is

(1) 64 g (2) 40 g
(3) 32 g (4) 256 g

11. In photo electric effect

A. The photocurrent is proportional to the intensity of the incident radiation.

B. Maximum Kinetic energy with which photoelectrons are emitted depends on the intensity of incident light.

C. Max. K.E with which photoelectrons are emitted depends on the frequency of incident light.

D. The emission of photoelectrons require a minimum threshold intensity of incident radiation.

E. Max. K.E of the photoelectrons is independent of the frequency of the incident light.

Choose the correct answer from the options given below:

(1) A and C only (2) A and E only
(3) B and C only (4) A and B only

12. The ratio of wavelength of spectral lines H_α and H_β in the Balmer series is $\frac{x}{20}$. The value of x is ___________

13. The angular momentum for the electron in Bohr's orbit is L. If the electron is assumed to revolve in second orbit of hydrogen atom, then the change in angular momentum will be :

(1) $\frac{L}{2}$ (2) zero
(3) L (4) 2L

14. The de Broglie wavelength of a molecule in a gas at room temperature (300 K) is λ_1. If the temperature of the gas is increased to 600 K, then the de Broglie wavelength of the same gas molecule becomes

(1) $\frac{1}{\sqrt{2}}\lambda_1$ (2) $2\lambda_1$
(3) $\frac{1}{2}\lambda_1$ (4) $\sqrt{2}\lambda_1$

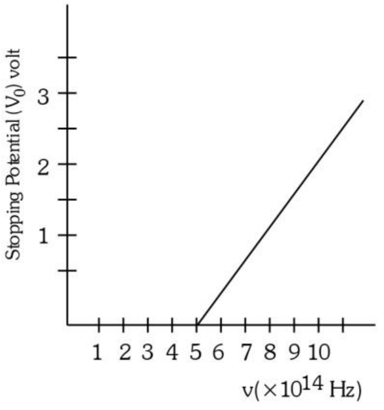
15. The decay constant for a radioactive nuclide is $1.5\times10^{-5}\,s^{-1}$. Atomic of the substance is 60 g $mole^{-1}$, $\left(N_A = 6\times10^{23}\right)$. The activity of 1.0 μg of the substance is _____ $\times10^{10}$ Bq.

16. The half-life of a radioactive substance is T. The time taken, for disintegrating $\frac{7}{8}$th part of its original mass will be :

(1) 3T
(2) 8T
(3) T
(4) 2T

SOLUTION

17. The variation of stopping potential (V_0) as a function of the frequency (ν) of the incident light for a metal is shown in figure. The work function of the surface is



(1) 18.6 eV (2) 2.98 eV
(3) 2.07 eV (4) 1.36 eV

18. If 917 Å be the lowest wavelength of Lyman series then the lowest wavelength of Balmer series will be________Å.

19. A metallic surface is illuminated with radiation of wavelength λ, the stopping potential is V_o. If the same surface is illuminated with radiation of wavelength 2λ, the stopping potential becomes $\frac{V_o}{4}$. The threshold wavelength for this metallic surface will be -

(1) $\frac{\lambda}{4}$ (2) 4λ
(3) $\frac{3}{2}\lambda$ (4) 3λ

20. Two radioactive elements A and B initially have same number of atoms. The half life of A is same as the average life of B. If λ_A and λ_B are decay constants of A and B respectively, then choose the correct relation from the given options.

(1) $\lambda_A = \lambda_B$ (2) $\lambda_A = 2\lambda_B$
(3) $\lambda_A = \lambda_B \ln 2$ (4) $\lambda_A \ln 2 = \lambda_B$

21. A monochromatic light is incident on a hydrogen sample in ground state. Hydrogen atoms absorb a fraction of light and subsequently emit radiation of six different wavelengths. The frequency of incident light is $x \times 10^{15}$ Hz. The value of x is ________. (Given $h = 4.25 \times 10^{-15}$ eVs)

22. The ratio of the de-Broglie wavelengths of proton and electron having same kinetic energy:

(Assume $m_p = m_e \times 1849$)

(1) 1 : 43 (2) 1 : 30
(3) 1 : 62 (4) 2 : 43

23. The energy of He^+ ion in its first excited state is. (The ground state energy for the Hydrogen atom is –13.6 eV):

(1) –3.4 eV
(2) –54.4 eV
(3) –13.6 eV
(4) –27.2 eV

24 A nucleus disintegrates into two nuclear parts, in such a way that ratio of their nuclear sizes is $1 : 2^{1/3}$. Their respective speed have a ratio of n : 1. The value of n is ______

25. A proton and an α-particle are accelerated from rest by 2V and 4V potentials, respectively. The ratio of their de-Broglie wavelength is:

(1) 4:1 (2) 2:1
(3) 8:1 (4) 16:1

26. A 12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. The number of spectral lines emitted will be:

(1) 2 (2) 1
(3) 3 (4) 4

SOLUTION

27. A common example of alpha decay is

$${}^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}_2He^4 + Q$$

Given :

${}^{238}_{92}U = 238.05060u,$

${}^{234}_{90}Th = 234.04360u,$

${}^{4}_{2}He = 4.00260u,$ and

$1u = 931.5\dfrac{MeV}{c^2}$

The energy released (Q) during the alpha decay of ${}^{238}_{92}U$ is _____ MeV

28. The difference between threshold wavelengths for two metal surfaces A and B having work function $\phi_A = 9eV$ and $\phi_B = 4.5eV$ in nm is:

(Given, hc = 1242 eV nm)

(1) 264

(2) 138

(3) 276

(4) 540

29. $\begin{matrix}238\\92\end{matrix}A \to \begin{matrix}234\\90\end{matrix}B + \begin{matrix}4\\2\end{matrix}D + Q$

In the given nuclear reaction, the approximate amount of energy released will be :

[Given, mass of $\begin{matrix}238\\92\end{matrix}A = 238.05079 \times 931.5\ MeV/c^2$,

mass of $\begin{matrix}234\\90\end{matrix}B = 234.04363 \times 931.5\ MeV/c^2$,

mass of $\begin{matrix}4\\2\end{matrix}D = 4.00260 \times 931.5\ MeV/c^2$]

(1) 3.82 MeV (2) 5.9 MeV

(3) 2.12 MeV (4) 4.25 MeV

30. The radius of 2^{nd} orbit of He^+ of Bohr's model is r_1 and that of fourth orbit of Be^{3+} is represented as r_2. Now the ratio $\frac{r_2}{r_1}$ is x : 1. The value of x is __________

31. **Assertion A :** The binding energy per nucleon is practically independent of the atomic number for nuclei of mass number in the range 30 to 170.

Reason R : Nuclear force is short ranged.

In the light of the above statements, choose the ***correct*** answer from the options given below

(1) Both **A** and **R** are true but **R** is **NOT** the correct explanation of **A**

(2) **A** is true but **R** is false

(3) **A** is false but **R** is true

(4) Both **A** and **R** are true and **R** is the correct explanation of **A**

32. **Statement I :** Out of microwaves, infrared rays and ultraviolet rays, ultraviolet rays are the most effective for the emission of electrons from a metallic surface.

Statement II : Above the threshold frequency, the maximum kinetic energy of photoelectrons is inversely proportional to the frequency of the incident light.

In the light of above statements, choose the ***correct*** answer from the options given below

(1) Statement I is true but Statement II is false

(2) Both Statement I and Statement II are true

(3) Statement I is false but Statement II is true

(4) Both Statement I and Statement II are false

33. An atom absorbs a photon of wavelength 500 nm and emits another photon of wavelength 600 nm. The net energy absorbed by the atom in this process is $n \times 10^{-4}$eV. The value of n is _______.

[Assume the atom to be stationary during the absorption and emission process]

(Take $h = 6.6 \times 10^{-34}$ Js and $c = 3 \times 10^8$ m/s).

SOLUTION

34 The half-life of a radioactive nucleus is 5 years, The fraction of the original sample that would decay in 15 years is :

(1) $\frac{1}{8}$ (2) $\frac{1}{4}$

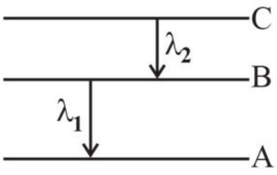
(3) $\frac{7}{8}$ (4) $\frac{3}{4}$

35. The de Broglie wavelength of an electron having kinetic energy E is λ. If the kinetic energy of electron becomes $\frac{E}{4}$, then its de-Broglie wavelength will be :

(1) $\frac{\lambda}{\sqrt{2}}$ (2) $\frac{\lambda}{2}$

(3) 2λ (4) $\sqrt{2}\lambda$

36. As per given figure A, B and C are the first, second and third excited energy level of hydrogen atom respectively. If the ratio of the two wavelengths $\left(\text{i.e.} \frac{\lambda_1}{\lambda_2}\right)$ is $\frac{7}{4n}$, then the value of n will be ________ .



SOLUTION

Modern Physics

1. 3
2. 2
3. 425
4. 3
5. 1
6. 16
7. 1
8. 4
9. 121
10. 4
11. 1
12. 27
13. 3
14. 1
15. 15
16. 1
17. 3
18. 3668
19. 4
20. 3
21. 3
22. 1
23. 3
24. 2
25. 1
26. 3
27. 4
28. 2
29. 4
30. 2
31. 4
32. 1
33. 4125
34. 3
35. 3
36. 5

1. The de Broglie wavelengths of a proton and an α particle are λ and 2λ respectively. The ratio of the velocities of proton and α particle will be :

(1) 1 : 8 (2) 1 : 2
(3) 4 : 1 (4) 8 : 1

2. The minimum energy required by a hydrogen atom in ground state to emit radiation in Balmer series is nearly :

(1) 1.5 eV
(2) 13.6 eV
(3) 1.9 eV
(4) 12.1 eV

3. The radius of a nucleus of mass number 64 is 4.8 fermi. Then the mass number of another nucleus having radius of 4 fermi is $\frac{1000}{x}$, where x is _____.

4. From the statements given below :

(A) The angular momentum of an electron in n^{th} orbit is an integral multiple of h.
(B) Nuclear forces do not obey inverse square law.
(C) Nuclear forces are spin dependent.
(D) Nuclear forces are central and charge independent.
(E) Stability of nucleus is inversely proportional to the value of packing fraction.

Choose the correct answer from the options given below :

(1) (A), (B), (C), (D) only
(2) (A), (C), (D), (E) only
(3) (A), (B), (C), (E) only
(4) (B), (C), (D), (E) only

5. Monochromatic light of frequency 6×10^{14} Hz is produced by a laser. The power emitted is 2×10^{-3} W. How many photons per second on an average, are emitted by the source ?
(Given $h = 6.63 \times 10^{-34}$ Js)

(1) 9×10^{18} (2) 6×10^{15}
(3) 5×10^{15} (4) 7×10^{16}

6. A particular hydrogen - like ion emits the radiation of frequency 3×10^{15} Hz when it makes transition from n = 2 to n = 1. The frequency of radiation emitted in transition from n = 3 to n = 1 is $\frac{x}{9} \times 10^{15}$ Hz, when x = ______.

7. The radius of third stationary orbit of electron for Bohr's atom is R. The radius of fourth stationary orbit will be:

(1) $\frac{4}{3}R$
(2) $\frac{16}{9}R$
(3) $\frac{3}{4}R$
(4) $\frac{9}{16}R$

8. A convex lens of focal length 40 cm forms an image of an extended source of light on a photo-electric cell. A current I is produced. The lens is replaced by another convex lens having the same diameter but focal length 20 cm. The photoelectric current now is :

(1) $\frac{I}{2}$ (2) 4 I
(3) 2 I (4) I

9. In a nuclear fission process, a high mass nuclide $(A \approx 236)$ with binding energy 7.6 MeV/Nucleon dissociated into middle mass nuclides $(A \approx 118)$, having binding energy of 8.6 MeV/Nucleon. The energy released in the process would be ____ MeV.

10. The atomic mass of ${}_6C^{12}$ is 12.000000 u and that of ${}_6C^{13}$ is 13.003354 u. The required energy to remove a neutron from ${}_6C^{13}$, if mass of neutron is 1.008665 u, will be :

(1) 62. 5 MeV
(2) 6.25 MeV
(3) 4.95 MeV
(4) 49.5 MeV

SOLUTION - CLICK

11. The threshold frequency of a metal with work function 6.63 eV is :

(1) 16×10^{15} Hz

(2) 16×10^{12} Hz

(3) 1.6×10^{12} Hz

(4) 1.6×10^{15} Hz

12. An object is placed in a medium of refractive index 3. An electromagnetic wave of intensity 6×10^8 W/m^2 falls normally on the object and it is absorbed completely. The radiation pressure on the object would be (speed of light in free space $= 3 \times 10^8$ m/s) :

(1) 36 Nm^{-2}
(2) 18 Nm^{-2}
(3) 6 Nm^{-2}
(4) 2 Nm^{-2}

13. If Rydberg's constant is R, the longest wavelength of radiation in Paschen series will be $\frac{\alpha}{7R}$, where $\alpha =$ ________.

14 The de-Broglie wavelength of an electron is the same as that of a photon. If velocity of electron is 25% of the velocity of light, then the ratio of K.E. of electron and K.E. of photon will be:

(1) $\frac{1}{1}$ (2) $\frac{1}{8}$

(3) $\frac{8}{1}$ (4) $\frac{1}{4}$

15. The explosive in a Hydrogen bomb is a mixture of $_1H^2$, $_1H^3$ and $_3Li^6$ in some condensed form. The chain reaction is given by

$_3Li^6 + {}_0n^1 \rightarrow {}_2He^4 + {}_1H^3$

$_1H^2 + {}_1H^3 \rightarrow {}_2He^4 + {}_0n^1$

During the explosion the energy released is approximately

[Given : M(Li) = 6.01690 amu. M ($_1H^2$) = 2.01471 amu. M ($_2He^4$) = 4.00388amu, and 1 amu = 931.5 MeV]

(1) 28.12 MeV (2) 12.64 MeV
(3) 16.48 MeV (4) 22.22 MeV

SOLUTION - CLICK

16. When a hydrogen atom going from n = 2 to n = 1 emits a photon, its recoil speed is $\frac{x}{5}$ *m/s*. Where x = ______ . (Use : mass of hydrogen atom $= 1.6 \times 10^{-27}$ kg)

17. Two sources of light emit with a power of 200 W. The ratio of number of photons of visible light emitted by each source having wavelengths 300 nm and 500 nm respectively, will be :

(1) 1 : 5 (2) 1 : 3
(3) 5 : 3 (4) 3 : 5

18. **Statement I :** Most of the mass of the atom and all its positive charge are concentrated in a tiny nucleus and the electrons revolve around it, is Rutherford's model.

Statement II : An atom is a spherical cloud of positive charges with electrons embedded in it, is a special case of Rutherford's model.

In the light of the above statements, choose the most appropriate from the options given below.

(1) Both statement I and statement II are false
(2) Statement I is false but statement II is true
(3) Statement I is true but statement II is false
(4) Both statement I and statement II are true

19. Hydrogen atom is bombarded with electrons accelerated through a potential different of V, which causes excitation of hydrogen atoms. If the experiment is being formed at T = 0 K. The minimum potential difference needed to observe any Balmer series lines in the emission spectra will be $\frac{\alpha}{10}$V, where $\alpha =$ ________.

20. The work function of a substance is 3.0 eV. The longest wavelength of light that can cause the emission of photoelectrons from this substance is approximately:

(1) 215 nm (2) 414 nm
(3) 400 nm (4) 200 nm

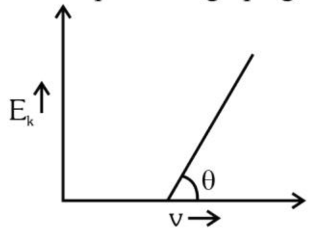
21. The ratio of the magnitude of the kinetic energy to the potential energy of an electron in the 5th excited state of a hydrogen atom is :

(1) 4 (2) $\frac{1}{4}$

(3) $\frac{1}{2}$ (4) 1

22 A electron of hydrogen atom on an excited state is having energy $E_n = -0.85$ eV. The maximum number of allowed transitions to lower energy level is ….. .

23. For the photoelectric effect, the maximum kinetic energy (E_k) of the photoelectrons is plotted against the frequency (v) of the incident photons as shown in figure. The slope of the graph gives



(1) Ratio of Planck's constant to electric charge
(2) Work function of the metal
(3) Charge of electron
(4) Planck's constant

24. In a nuclear fission reaction of an isotope of mass M, three similar daughter nuclei of same mass are formed. The speed of a daughter nuclei in terms of mass defect ΔM will be :

(1) $\sqrt{\frac{2c\Delta M}{M}}$ (2) $\frac{\Delta Mc^2}{3}$

(3) $c\sqrt{\frac{2\Delta M}{M}}$ (4) $c\sqrt{\frac{3\Delta M}{M}}$

25. An electron revolving in n^{th} Bohr orbit has magnetic moment μ_n. If $\mu_n \alpha n^x$, the value of x is:

(1) 2 (2) 1
(3) 3 (4) 0

26. If the total energy transferred to a surface in time t is 6.48×10^5 J, then the magnitude of the total momentum delivered to this surface for complete absorption will be :

(1) 2.46×10^{-3} kg m/s
(2) 2.16×10^{-3} kg m/s
(3) 1.58×10^{-3} kg m/s
(4) 4.32×10^{-3} kg m/s

27. If the wavelength of the first member of Lyman series of hydrogen is λ. The wavelength of the second member will be

(1) $\frac{27}{32}\lambda$ (2) $\frac{32}{27}\lambda$

(3) $\frac{27}{5}\lambda$ (4) $\frac{5}{27}\lambda$

28. When a metal surface is illuminated by light of wavelength λ, the stopping potential is 8V. When the same surface is illuminated by light of wavelength 3λ, stopping potential is 2V. The threshold wavelength for this surface is :

(1) 5λ (2) 3λ
(3) 9λ (4) 4.5λ

29. The mass defect in a particular reaction is 0.4g. The amount of energy liberated is $n \times 10^7$ kWh, where n = _____.
(speed of light = 3×10^8 m/s)

30. In a photoelectric effect experiment a light of frequency 1.5 times the threshold frequency is made to fall on the surface of photosensitive material. Now if the frequency is halved and intensity is doubled, the number of photo electrons emitted will be:

(1) Doubled (2) Quadrupled
(3) Zero (4) Halved

31 The mass number of nucleus having radius equal to half of the radius of nucleus with mass number 192 is:

(1) 24 (2) 32
(3) 40 (4) 20

32. A nucleus has mass number A_1 and volume V_1. Another nucleus has mass number A_2 and volume V_2. If relation between mass number is $A_2 = 4A_1$, then $\frac{V_2}{V_1} =$ ________.

SOLUTION - CLICK

Answer Key

1. 4
2. 4
3. 27
4. 3
5. 3
6. 32
7. 2
8. 4
9. 236
10. 3
11. 4
12. 3
13. 144
14. 2
15. 4
16. 17
17. 4
18. 3
19. 121
20. 2
21. 3
22. 6
23. 4
24. 3
25. 2
26. 2
27. 1
28. 3
29. 1
30. 3
31. 1
32. 4

SOLUTION - CLICK

1. Which of the following nuclear fragments corresponding to nuclear fission between neutron $\left({}^{1}_{0}n\right)$ and uranium isotope $\left({}^{235}_{92}U\right)$ is correct:

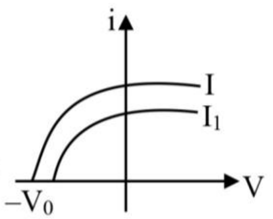
(1) ${}^{144}_{56}Ba + {}^{89}_{36}Kr + 4{}^{1}_{0}n$

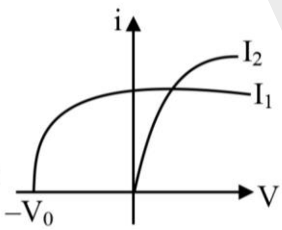
(2) ${}^{140}_{56}Xe + {}^{94}_{38}Sr + 3{}^{1}_{0}n$

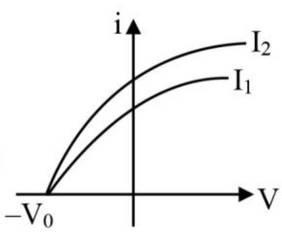
(3) ${}^{153}_{51}Sb + {}^{99}_{41}Nb + 3{}^{1}_{0}n$

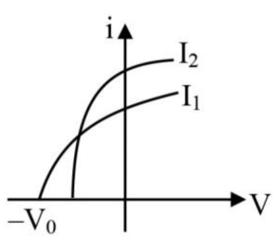
(4) ${}^{144}_{56}Ba + {}^{89}_{36}Kr + 3{}^{1}_{0}n$

2. Which figure shows the correct variation of applied potential difference (V) with photoelectric current (I) at two different intensities of light ($I_1 < I_2$) of same wavelengths :

(1)


(2)


(3)


(4)


3. A hydrogen atom changes its state from n = 3 to n = 2. Due to recoil, the percentage change in the wave length of emitted light is approximately 1×10^{-n}. The value of n is__________.
[Given Rhc = 13.6 eV, hc = 1242 eV nm, h = 6.6×10^{-34} J s, mass of the hydrogen atom = 1.6×10^{-27} kg]

4. **Assertion A :** Number of photons increases with increase in frequency of light.
Reason R : Maximum kinetic energy of emitted electrons increases with the frequency of incident radiation.
In the light of the above statements, choose the **most appropriate** answer from the options given below :
(1) Both **A** and **R** are correct and **R** is **NOT** the correct explanation of **A**.
(2) **A** is correct but **R** is not correct.
(3) Both **A** and **R** are correct and **R** is the correct explanation of **A**.
(4) **A** is not correct but **R** is correct.

5. According to Bohr's theory, the moment of momentum of an electron revolving in 4th orbit of hydrogen atom is :

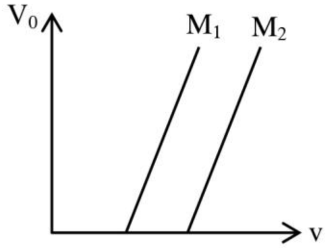
(1) $8\frac{h}{\pi}$ (2) $\frac{h}{\pi}$

(3) $2\frac{h}{\pi}$ (4) $\frac{h}{2\pi}$

6. The disintegration energy Q for the nuclear fission of ${}^{235}U \rightarrow {}^{140}Ce + {}^{94}Zr + n$ is ____MeV.
Given atomic masses of
${}^{235}U : 235.0439u; {}^{140}Ce; 139.9054u$,
${}^{94}Zr : 93.9063u; n : 1.0086u$,
Value of $c^2 = 931$ MeV/u.

SOLUTION - CLICK

7. Given below are two statements:



Statement-I: Figure shows the variation of stopping potential with frequency (ν) for the two photosensitive materials M_1 and M_2. The slope gives value of $\frac{h}{e}$, where h is Planck's constant, e is the charge of electron.

Statement-II: M_2 will emit photoelectrons of greater kinetic energy for the incident radiation having same frequency.

In the light of the above statements, choose the most appropriate answer from the options given below.

(1) **Statement-I** is correct and **Statement-II** is incorrect.
(2) **Statement-I** is incorrect but **Statement-II** is correct.
(3) Both **Statement-I** and **Statement-II** are incorrect.
(4) Both **Statement-I** and **Statement-II** are correct.

8. An electron rotates in a circle around a nucleus having positive charge Ze. Correct relation between total energy (E) of electron to its potential energy (U) is:

(1) E = 2U (2) 2E = 3U
(3) E = U (4) 2E = U

9. If three helium nuclei combine to form a carbon nucleus then the energy released in this reaction is .... $\times 10^{-2}$ MeV. (Given 1 u = 931 MeV/c^2, atomic mass of helium = 4.002603 u)

10. Which of the following statement is not true about stopping potential (V_0)?

(1) It depends on the nature of emitter material.
(2) It depends upon frequency of the incident light.
(3) It increases with increase in intensity of the incident light.
(4) It is 1/e times the maximum kinetic energy of electrons emitted.

SOLUTION - [CLICK]()

11. The angular momentum of an electron in a hydrogen atom is proportional to : (Where r is the radius of orbit of electron)

(1) $\sqrt{r}$ (2) $\frac{1}{r}$
(3) r (4) $\frac{1}{\sqrt{r}}$

12. The shortest wavelength of the spectral lines in the Lyman series of hydrogen spectrum is 915 Å. The longest wavelength of spectral lines in the Balmer series will be _______ Å.

13. The ratio of the shortest wavelength of Balmer series to the shortest wavelength of Lyman series for hydrogen atom is :

(1) 4 : 1 (2) 1 : 2
(3) 1 : 4 (4) 2 : 1

14. Which of the following phenomena does not explain by wave nature of light.

(A) reflection (B) diffraction
(C) photoelectric effect (D) interference
(E) polarization

Choose the **most appropriate** answer from the options given below :

(1) E only (2) C only
(3) B, D only (4) A, C only

15. In photoelectric experiment energy of 2.48 eV irradiates a photo sensitive material. The stopping potential was measured to be 0.5 V. Work function of the photo sensitive material is :

(1) 0.5 eV (2) 1.68 eV
(3) 2.48 eV (4) 1.98 eV

16. Radius of a certain orbit of hydrogen atom is 8.48 Å. If energy of electron in this orbit is E/x, then x = _________.
(Given a_0 = 0.529Å, E = energy of electron in ground state)

17. The longest wavelength associated with Paschen series is : (Given $R_H = 1.097 \times 10^7$ SI unit)

(1) 1.094×10^{-6}m (2) 2.973×10^{-6}m
(3) 3.646×10^{-6}m (4) 1.876×10^{-6}m

18. When UV light of wavelength 300 nm is incident on the metal surface having work function 2.13 eV, electron emission takes place. The stopping potential is : (Given hc = 1240 eV nm)
(1) 4 V (2) 4.1 V
(3) 2 V (4) 1.5 V

19. In Franck-Hertz experiment, the first dip in the current-voltage graph for hydrogen is observed at 10.2 V. The wavelength of light emitted by hydrogen atom when excited to the first excitation level is ______ nm.
(Given hc = 1245 eV nm, e = 1.6×10^{-19}C).

20. Average force exerted on a non-reflecting surface at normal incidence is 2.4×10^{-4}N. If 360 W/cm^2 is the light energy flux during span of 1 hour 30 minutes. Then the area of the surface is:
(1) 0.2 m^2 (2) 0.02 m^2
(3) 20 m^2 (4) 0.1 m^2

21. A proton and an electron are associated with same de-Broglie wavelength. The ratio of their kinetic energies is:
(Assume h = 6.63×10^{-34} J s, $m_e = 9.0 \times 10^{-31}$ kg and m_p = 1836 times m_e)
(1) 1 : 1836 (2) $1 : \frac{1}{1836}$
(3) $1 : \frac{1}{\sqrt{1836}}$ (4) $1 : \sqrt{1836}$

22 Binding energy of a certain nucleus is 18×10^8 J. How much is the difference between total mass of all the nucleons and nuclear mass of the given nucleus:
(1) 0.2 μg (2) 20 μg
(3) 2 μg (4) 10 μg

23. In an alpha particle scattering experiment distance of closest approach for the α particle is 4.5×10^{-14} m. If target nucleus has atomic number 80, then maximum velocity of α-particle is _______ $\times 10^5$ m/s approximately.
($\frac{1}{4\pi\epsilon_0} = 9\times10^9$ SI unit, mass of α particle $= 6.72\times10^{-27}$kg)

24. In a hypothetical fission reaction
$_{92}X^{236} \rightarrow {}_{56}Y^{141} + {}_{36}Z^{92} + 3R$
The identity of emitted particles (R) is :
(1) Proton (2) Electron
(3) Neutron (4) γ-radiations

25. A proton and an electron have the same de Broglie wavelength. If K_p and K_e be the kinetic energies of proton and electron respectively. Then choose the correct relation :
(1) $K_p > K_e$ (2) $K_p = K_e$
(3) $K_p = K_e^2$ (4) $K_p < K_e$

26. If M_o is the mass of isotope $^{12}_{5}B$, M_p and M_n are the masses of proton and neutron, then nuclear binding energy of isotope is :
(1) $(5 M_p + 7M_n - M_o)C^2$
(2) $(M_o - 5M_p)C^2$
(3) $(M_o - 12M_n)C^2$
(4) $(M_o - 5M_p - 7M_n)C^2$

27. A proton, an electron and an alpha particle have the same energies. Their de-Broglie wavelengths will be compared as:
(1) $\lambda_e > \lambda_\alpha > \lambda_p$ (2) $\lambda_\alpha < \lambda_p < \lambda_e$
(3) $\lambda_p < \lambda_e < \lambda_\alpha$ (4) $\lambda_p > \lambda_e > \lambda_\alpha$

28. The energy equivalent of 1g of substance is:
(1) 11.2×10^{24} MeV (2) 5.6×10^{12} MeV
(3) 5.6 eV (4) 5.6×10^{26} MeV

29. A star has 100% helium composition. It starts to convert three ^{4}He into one ^{12}C via triple alpha process as $^4He + {}^4He + {}^4He \rightarrow {}^{12}C + Q$. The mass of the star is 2.0×10^{32} kg and it generates energy at the rate of 5.808×10^{30} W. The rate of converting these ^{4}He to ^{12}C is $n \times 10^{42}$ s^{-1}, where n is _______.
[Take, mass of ^{4}He = 4.0026 u, mass of ^{12}C = 12 u]

SOLUTION - CLICK

30. A nucleus at rest disintegrates into two smaller nuclei with their masses in the ratio of 2:1. After disintegration they will move :-

(1) In opposite directions with speed in the ratio of 1:2 respectively

(2) In opposite directions with speed in the ratio of 2:1 respectively

(3) In the same direction with same speed.

(4) In opposite directions with the same speed.

31. A hydrogen atom in ground state is given an energy of 10.2 eV. How many spectral lines will be emitted due to transition of electrons ?

(1) 6 (2) 3

(3) 10 (4) 1

32. UV light of 4.13 eV is incident on a photosensitive metal surface having work function 3.13 eV. The maximum kinetic energy of ejected photoelectrons will be :

(1) 4.13 eV (2) 1 eV

(3) 3.13 eV (4) 7.26 eV

33. The energy released in the fusion of 2 kg of hydrogen deep in the sun is E_H and the energy released in the fission of 2 kg of ^{235}U is E_U. The ratio $\frac{E_H}{E_U}$ is approximately :

(Consider the fusion reaction as $4\,{}_1^1H + 2e^- \rightarrow {}_2^4He + 2\nu + 6\gamma + 26.7\,MeV$, energy released in the fission reaction of ^{235}U is 200 *MeV* per fission nucleus and $N_A = 6.023 \times 10^{23}$)

(1) 9.13 (2) 15.04

(3) 7.62 (4) 25.6

SOLUTION - CLICK

Answer Key

1. 4
2. 3
3. 7
4. 4
5. 3
6. 208
7. 1
8. 4
9. 727
10. 3
11. 1
12. 6588
13. 1
14. 2
15. 4
16. 16
17. 4
18. 3
19. 122
20. 2
21. 1
22. 2
23. 156
24. 3
25. 4
26. 1
27. 2
28. 4
29. NTA gave 5 (*Correct answer should be 15*)
30. 1
31. 4
32. 2
33. 3

SOLUTION - CLICK